

DIVISION 600 - INCIDENTAL CONSTRUCTION

*SECTION 603 -- CULVERTS AND STORM DRAINS***Description**

1.1 This work shall consist of furnishing and installing, or removing and relaying, pipes, pipe end sections, and pipe sleeves at the locations shown or ordered, including the necessary joints, fittings, and connections as required. Common structure excavation to the depth specified in 206.4.1, secondary excavation required in the imperfect trench method, bedding and backfill shall be included in this work.

Materials**2.1 Reinforced Concrete Pipe, Circular.**

2.1.1 This pipe shall conform to the requirements of AASHTO M 170 (AASHTO M 170M), except as follows: When fly-ash is used, only Class F, in accordance with AASHTO M 295 will be allowed. Wall A thickness will be allowed in Class III pipe only. When the plans call for reinforced concrete pipe capable of withstanding an ultimate load greater than 3750 D (175 kPa), the design requirements of Class V shall be met with further provision that the pipe will withstand the ultimate D-load specified.

2.1.2 Basis of acceptance of concrete pipe shall conform to AASHTO M 170 (AASHTO M 170M), Section 5.1.1. Test requirements shall be as provided in Section 11 with the further provision that the pipe will withstand an additional ten percent of the D-load specified or brought to destruction. Permissible variation in pipe tolerances shall conform to AASHTO M 170 (AASHTO M 170M), Section 12.

2.1.3 Workmanship and finish shall conform to AASHTO M 170 (AASHTO M 170M), Section 12. Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements of AASHTO M 170 (AASHTO M 170M), Section 15. Individual sections of pipe may be rejected because of the following reasons:

- (a) Fracture or cracks passing through the wall, except for a single end crack that does not exceed the depth of a joint.
- (b) Defects that indicate imperfect proportioning, mixing, and molding.
- (c) Surface defects indicating honey-combed or open texture.
- (d) Damaged or cracked ends where such damage would prevent making a satisfactory joint.
- (e) Any continuous crack having a surface width of 0.01 in (0.3 mm) or more and extending for a length of 12 in (300 mm) or more, regardless of position in the wall of the pipe.
- (f) The exposure of any steel in the barrel or the outside of the pipe indicating the displacement of reinforcement. Steel exposed at the ends will not be cause for rejection if a satisfactory joint can be made.

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Table 1E - Minimum Strength Requirements (English)

D-Load to produce the ultimate load = Class	D-Load to produce a 0.01 in crack	AASHTO Designation Class
1500 D	1000 D	II
2000 D	1350 D	III
3000 D	2000 D	IV
3750 D	3000 D	V
4000 D	---	---

Table 1 - Minimum Strength Requirements (Metric)

Load to produce the ultimate load (kPa) = Class	Load to produce a 0.3 mm crack (kPa)	AASHTO Designation Class
75	50	II
100	65	III
150	100	IV
175	140	V
200	----	---

2.1.4 Markings on pipe shall conform to AASHTO M 170 (AASHTO M170M), Section 16 with the following information clearly marked on each section of pipe.

- (a) The pipe class and specification designation
- (b) The date of manufacture
- (c) The name or trademark of the manufacturer
- (d) Identification of the plant

2.1.5 Concrete pipe shall be joined by using flexible water tight gaskets conforming to AASHTO M 198.

2.2 Corrugated Metal Pipes and Pipe -Arches--Steel or Aluminum.

2.2.1 Except as provided below, steel pipes and pipe-arches shall conform to AASHTO M 36/M 36M, Type I or II, and aluminum pipes and pipe-arches shall conform to AASHTO M 196/M 196M, Type I or II.

2.2.1.1 To facilitate field jointing, the ends of individual pipe sections shall meet the requirements of Section 7.7.1 of AASHTO M 36/M 36M and Section 7.5.1 of AASHTO M 196.

2.2.1.2 Section 9.1.3 of AASHTO M 36/M 36M and Section 9.1.5 of AASHTO M 196 do not apply.

2.2.2 The specified thickness in the case of steel and the nominal thickness in the case of aluminum shall be as shown on the plans. The minimum thickness of steel culvert sheets shall meet the

requirements of AASHTO M 218 and the minimum thickness of aluminum culvert sheets shall meet the requirements of AASHTO M 197/M 197M.

Table 2E - Thickness and Equivalent Gauges (English)

Steel	Aluminum	
Thickness, inches*		Sheet Gauge Number
"Specified"	"Specified"	
0.064	0.060	16
0.079	0.075	14
0.109	0.105	12
0.138	0.135	10
0.168	0.164	8

*Thickness measured on tangent of corrugation.

Table 2 - Thickness and Equivalent Gauges (Metric)

Steel	Aluminum
Thickness, mm*	
"Specified"	"Specified"
1.63	1.52
2.01	1.91
2.77	2.67
3.51	3.43
4.27	4.17

*Thickness measured on tangent of corrugation.

2.2.3 Strutted pipes shall be furnished 5 percent elongated, when specified.

2.3 Pipe Sleeve.

2.3.1 Pipe sleeves for electrical conduit shall be as specified in 614. Other pipe sleeves shall meet the load bearing requirement as well as special design considerations.

2.3.2 Steel pipe for pipe sleeve, bored, shall conform to ASTM A 53, with joints welded.

2.4 Pipe for Slope Drainage.

2.4.1 Corrugated polyethylene pipe for slope drain shall conform to the requirements of AASHTO M 294, Type C and shall be from an approved manufacturer as included on the Qualified Products List.

2.4.1.1 The pipe coupler for polyethylene pipe shall consist of a plastic coupler and 2 stainless steel bands installed on the exterior corrugations. Slope pipe coupling bands shall engage a minimum of two full corrugations of each pipe section being joined, shall be reinforced with a minimum of three high-strength nylon ties, and in all other respects shall meet the criteria for the "Downdrain Joint" category of Division II, Section 26 of the AASHTO Standard Specifications for Highway Bridges.

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2.4.2 Corrugated aluminized steel pipe for slope drain, when specified, shall meet the requirements of 2.2. The thickness shall meet the requirements of Table 3.

2.4.3 When the type of pipe material is not specified in the item description either Polyethylene pipe or aluminized steel pipe shall be furnished.

2.5 Pipe for Drives and Minor Approaches

2.5.1 It shall be the Contractor's option to furnish reinforced concrete pipe, corrugated aluminized steel pipe or corrugated aluminum pipe, unless otherwise specified, for pipe for drives and minor approaches. Reinforced concrete pipe shall meet the requirements of 2.1. Corrugated pipe shall meet the requirements of 2.2. The strength or thickness shall meet the requirements of Table 3.

Table 3 - Required Strength of Culvert Pipes

Material	Diameter	Strength Concrete	Thickness, inches (mm)	
			"Specified" Steel	"Nominal" Aluminum
Reinforced Concrete	All	2000 D (100 kPa)		
Corrugated Metal	12"-18"(300-450mm)		0.064 (1.626)	0.060 (1.524)
	24"-30"(600-750mm)		0.079 (2.007)	0.075 (1.905)
	36" (900 mm)		0.109 (2.769)	0.105 (2.667)

2.6 End Sections.

2.6.1 Metal End Sections.

2.6.1.1 Steel end sections shall be galvanized, sheet or corrugated as required, conforming to the requirements of AASHTO M 36/M 36M insofar as that specification applies. Aluminum end sections shall conform to the pertinent provisions of AASHTO M 196/M 196M and to the requirements shown on the plans. Sections shall be fabricated of the thickness of metal shown on the plans. When the item calls for metal end sections, either steel or aluminum shall be furnished, matching the pipe furnished.

2.6.1.2 Galvanized bolts may be used for the assembly of end sections where more than one piece is used to form the skirt. Bolts shall conform to ASTM A 325/A 325M.

2.6.2 Concrete End Sections.

2.6.2.1 Concrete end sections shall be reinforced concrete conforming to the pertinent provisions of 2.1 and to the requirements shown on the plans. Where a single cage of reinforcement is shown on the plans, sufficient steel shall be incorporated to maintain the integrity of the piece. Unless a different class is specified, end sections conforming to Class III minimum strength pipe shall be furnished.

2.6.3 Corrugated polyethylene pipe end sections shall meet the materials requirements of AASHTO M 294.

2.7 Granular backfill shall conform to the requirements of 209.

2.8 Cement mortar shall conform to the requirements of 707.

2.9 Plastic Pipe

2.9.1 Corrugated Polyethylene pipe shall conform to the requirements of AASHTO M 294, Type S, or Type C as specified on the plans.

2.9.2 Polyvinyl chloride (PVC) profile wall pipe shall conform to the requirements of AASHTO M 304. PVC pipe shall not be used in applications where it will be exposed to long term ultraviolet light without approved protection for the exposed area.

2.9.3 Basis of acceptance and test requirements of plastic pipe shall conform to AASHTO M 294 or AASHTO M 304 for the respective type of pipe. Only approved manufacturers will be allowed to furnish plastic pipe, as shown on the Qualified Products List. A certificate of compliance, as required by 106.04, shall be provided for each shipment.

2.9.4 Only soil tight pipefittings supplied or recommended by the manufacturer shall be used.

2.9.5 When the item description calls for Plastic Pipe (pipe material is not specified) either polyethylene or PVC shall be furnished and shall meet the requirements of 2.9.

2.10 Unsuitable material for bedding and backfilling pipes is either organic or one that cannot be placed to meet the required compaction or bearing capacity, with the effort normally required for this work. This definition shall only apply in cases where material properties, compaction or bearing requirements are not otherwise specified in the contract documents.

2.11 Concrete class F, flowable fill may be requested in writing as a substitute for backfill material. Approval in the form of a supplementary agreement shall be in consideration of, but not limited to, differential frost heaving due to dissimilar materials, unit weight, structural requirements, lack of permeability, and damming resulting from water flow cut off.

2.12 Drainage Pipe

2.12.1 When the Item calls for Drainage Pipe (pipe material is not specified) either concrete pipe 2000 D (100 kPa), metal pipe or plastic pipe for drainage pipe shall be furnished. Reinforced concrete pipe shall meet the requirements of 2.1. Metal pipe shall meet the requirements of 2.2. Plastic pipe shall meet the requirements of 2.9.

Construction Requirements

3.1 General.

3.1.1 Steam-cured or water-cured reinforced concrete pipe may be delivered to the project after 7 days from date of manufacture.

3.1.2 Do not lay or embed pipe in standing or running water. The Contractor shall provide for the temporary diversion of water in order to permit the installation of the culvert in a reasonably dry trench unless otherwise permitted. At all times prevent runoff and surface water from entering the trench.

3.1.2.1 When groundwater is present in the work area, dewater to maintain stability on in-place and imported materials and maintain water level below pipe bedding and foundation. Maintain control of water in trench before, during and after pipe installation, and until embedment is installed and sufficient backfill has been placed to prevent flotation of the pipe.

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3.1.3 Figure 1 has been made a part of these specifications for clarification.

3.1.4 Where soft or other unsuitable material is encountered, all of such unsuitable material, for the depth and width specified, shall be removed as shown in Figure 1-D.

3.1.5 Where bedrock or other incompressible material is encountered, it shall be removed as shown in Figure 1-C.

3.1.6 Material meeting the requirements of granular backfill or other approved material shall be used to backfill the spaces left by the excavation of material removed in accordance with 3.1.4 and 3.1.5. The material shall be uniformly compacted.

3.1.7 The width of trenches shall be held to a minimum consistent with the space required to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Trenching below the top of the pipe shall be kept to a maximum of three times the diameter of the pipe. The width of the trench above the pipe may be at the Contractor's option as shown in Figure 1-B.

3.1.7.1 For plastic pipe the minimum trench width shall be the greater of either the pipe outside diameter plus 16 in (400 mm) or the pipe outside diameter times 12 in 1.25, plus (300 mm).

3.1.8 The pipe shall be placed at the designated location on a prepared foundation so that the flow line of the pipe will conform to the required grade.

3.1.9 Where the top of the pipe would lie above the natural ground, sufficient compacted fill shall be constructed at pipe locations to insure that the pipe is placed in a trench equal in depth to at least the height of the pipe. The fill shall be constructed on each side of the pipe for a distance equal to at least 5 times the diameter of the pipe. Refer to Figure 1-A.

3.1.9 Where the top of the pipe would lie above the natural ground, sufficient compacted fill shall be constructed at pipe locations to insure that the pipe is placed in a trench equal in depth to at least the height of the pipe. The fill shall be constructed on each side of the pipe for a distance equal to at least 5 times the diameter of the pipe. Refer to Figure 1-A.

3.2 Bedding.

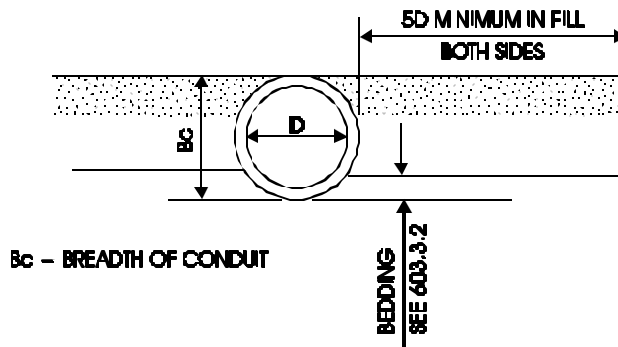
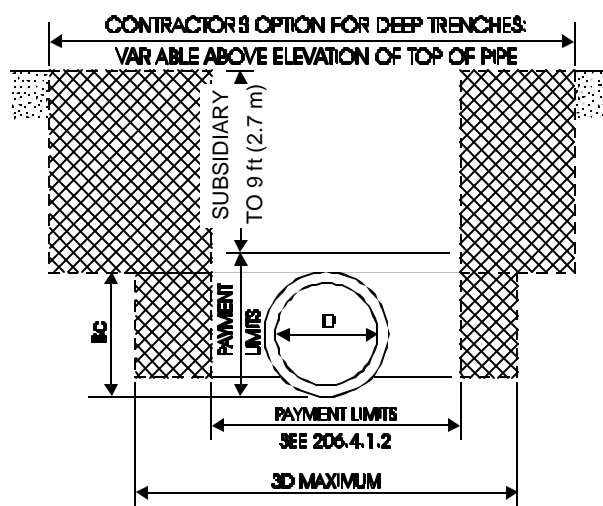
3.2.1 Bedding for pipes less than 48 in (1200 mm) in diameter or span shall consist of preparing and shaping the bottom of the trench to fit the lower 10 percent of the external height of the pipe with reasonable closeness and with uniform density and stability. Recesses shall be excavated for the bells of pipe.

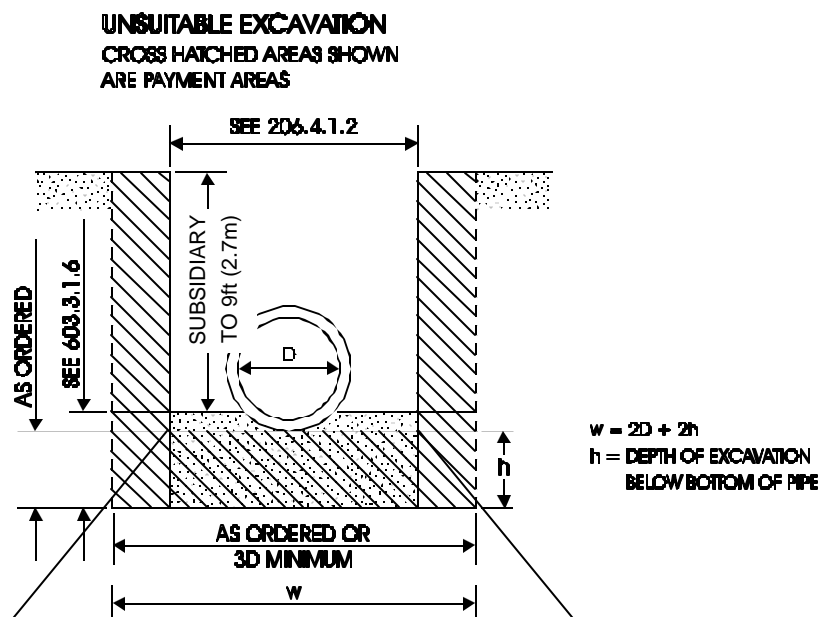
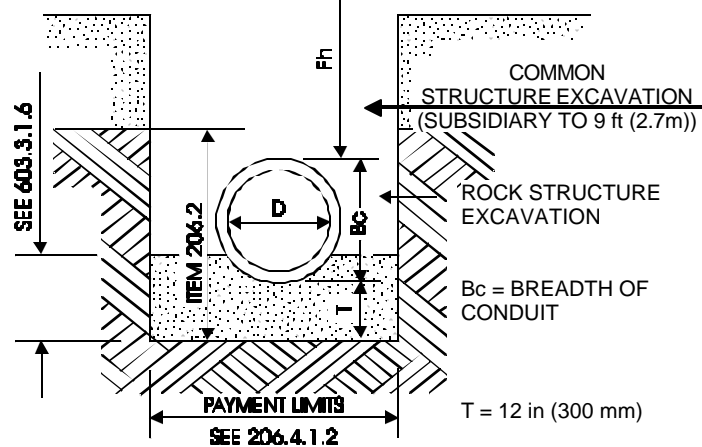
3.2.1.1 For plastic pipe the maximum particle size of material shall be 1-1/2 in (37.5 mm).

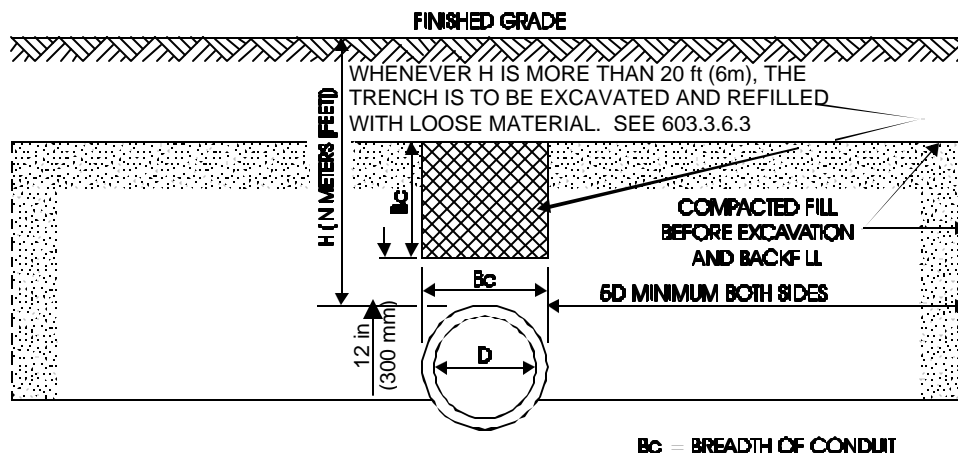
3.2.2 Bedding for all pipes 48 in (1200 mm) or more in diameter or span shall consist of bedding the pipe on a carefully prepared bed of granular backfill (sand), shaped by means of a template to fit the lower part of the pipe exterior for at least 15 percent of its external height.

EARTH

MINIMUM ELEVATION OF ORIGINAL GROUND
OR COMPACTED FILL PRIOR TO CONSTRUCTING
TRENCH AND INSTALLING PIPE

**FIG. 1-A - CULVERT DETAILS****EARTH****FIG. 1-B - CULVERT DETAILS**



IMPERFECT TRENCH METHOD**FIG. 1-E - CULVERT DETAILS****3.3 Laying and Joining Pipe.**

3.3.1 Proper facilities shall be provided for lowering the sections of pipe into the trench. Each section shall be securely attached to the adjoining section by the approved method for the type of joint used.

3.3.2 Elliptical pipe shall be so placed that major axes are within 5 degrees of the appropriate horizontal or vertical planes.

3.3.3 Joint seals for concrete pipe shall be joined in accordance with the manufacturer's recommendations.

3.3.3.1 The pipe ends shall be thoroughly cleaned before the joint is made. When it is necessary to shorten a length of reinforced concrete pipe, the pipe shall be sawed neatly using a masonry saw. The method of joining pipe sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even.

3.3.4 Sections of corrugated metal pipe shall be joined by enclosing joints with coupling bands of the same material as the pipe unless otherwise permitted.

3.3.5 Joints between dissimilar pipes shall be made in accordance with the recommendations of the pipe manufacturer.

3.3.6 Surfaces of aluminum pipe or aluminized steel pipe that are to be in contact with concrete, stone, or masonry shall be thoroughly coated with an approved zinc rich primer, 708-NH 1.50, or other approved coating, which shall be allowed to dry before the pipe is installed.

3.3.7 Anchor bolts shall be installed as shown on the plans on steel pipes and pipe-arches 48 in (1.2 m) and higher.

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3.3.8 The pipe coupler for pipe for slope drainage shall be installed in accordance with manufacturer's recommendations.3.4 End Sections.

3.4.1 End sections shall be installed in accordance with the recommendations of the manufacturer or as directed.

3.4.2 Necessary excavation shall be made to the required depth and contour for the section. Where ledge is encountered, the trench shall be excavated 8 in (200 mm) below the bottom of the end section and the area refilled to grade with suitable material, thoroughly tamped and carefully shaped.

3.4.3 Connections between concrete end sections and pipe culverts shall be by standard tongue and groove, bell and spigot or as ordered.

3.5 Backfilling.

3.5.1 All backfill material adjacent to a pipe shall be approved material. Backfill material shall be free from hard lumps, clods, or rocks larger than 3 in (75 mm) diameter and free of stumps and organic material. For plastic pipe hard lumps, clods, or rocks shall not be larger than 1-1/2 in (37.5 mm) diameter. Uniformly fine material shall be placed next to any pipe susceptible to damage.

3.5.2 All backfill material shall be compacted at near optimum moisture content, in layers not exceeding 6 in (150 mm) in compacted thickness, by pneumatic tampers, vibratory compactors, or other approved means. Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to insure that the compacted backfill material is in direct contact with the sides of the pipe. Fill at the sides of the pipe may be compacted by rolling or operating heavy equipment parallel with the culvert, provided care is taken to avoid displacement of or damage to the pipe. All backfill material shall be compacted to not less than 95 percent of AASHTO T 99, Method A.

3.5.3 The Contractor shall place an adequate protecting cover of earth or other approved material over the structure before allowing equipment or traffic to pass over it.

3.5.3.1 For plastic pipe the minimum cover with manufactured or processed aggregates shall be 2 ft (0.6 m) and with all other material 3 ft (1 m).

3.6 Imperfect trench.

3.6.1 When the proposed fill will be 20 ft (6 m) or more above the top of the pipe, the pipe shall be bedded, installed, and backfilled as specified, and the fill carried to a height above the pipe of at least equal to the external diameter of the pipe, plus 1 ft (300 mm) and thoroughly compacted in accordance with 3.5.2.

3.6.2 A trench equal in width to the external diameter shall then be constructed in the new fill directly over the pipe down to an elevation 1 ft (300 mm) above the top of the pipe as shown in Figure 1-E. Extreme care shall be exercised to keep the sides of this trench as nearly vertical as possible.

3.6.3 This trench shall then be refilled with soil material deposited in as loose state as possible. This material shall not be compacted before the embankment is constructed above it.

3.7 Workmanship. Any pipe which is not true to alignment and grade or which shows any undue settlement or deflection after laying or is damaged shall be removed and re-laid or replaced without extra compensation.

3.7.1 Deflection for plastic pipe shall not exceed 5 percent in the first 90 days. When deflection verification is considered necessary by the Engineer, all necessary manpower and equipment, including mandrels for such tests, will be provided by the Contractor and shall not be performed until 30 days after installation. When mandrel testing is required the mandrel diameter shall be:

The Specified Pipe Diameter minus Inside Diameter Tolerance ($1.5\% \times \text{Specified Diameter Pipe}$; Maximum Allowable is 0.5in (12 mm) minus allowable deflection ($5\% \times \text{Specified Pipe Diameter}$).

3.8 Special Requirements for Pipe Sleeve.

3.8.1 When no pipe or conduit is placed in the sleeve, the ends shall be closed by suitable caps.

3.8.2 The Contractor shall not backfill pipe sleeves until the necessary reference measurements have been made. When no pipe is placed in a non-metallic sleeve, in addition to the reference ties made by the Engineer, some means shall be provided to allow an electromagnetic current to be passed from end to end of the sleeve. The conductor shall consist of a continuous bare galvanized wire, minimum No. 9 gauge (3.8 mm), or sections of reinforcing rod welded or otherwise permanently joined. The conductor need not be new. The conductor shall be placed in the sleeve or within 6 in (150 mm) of the sleeve.

3.8.3 When the sleeve is to be installed by boring or drilling, the pavement shall not be disturbed. Suitable pits or trenches shall be excavated for the purpose of conducting the boring operations and for welding end joints of the pipe. Such pits shall be kept at least 2 ft (600 mm) clear of the edge of the pavement and necessary precautions taken to prevent caving.

3.8.3.1 Variation in the final position of the pipe from the established line and grade shall not exceed 0.1 of a foot per 10 feet (30 mm per 3 m).

3.8.3.2 Jetting will not be permitted.

3.8.3.3 When permitted, a method employing water may be used provided it can be demonstrated and guaranteed that the water forced through the inserted washing pipe will be used to wash out only the material trapped within the body of the pipe, and all the water will be returned through the pipe.

3.8.3.4 When the pilot hole method is employed, the holes are to be bored mechanically. The boring may be done using a pilot hole approximately 2 in (50 mm) in diameter bored the entire length of the crossing. This shall be checked for line and grade. If satisfactory, this hole shall serve as the center line of the larger diameter hole to be bored. Under this method, the use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings.

3.8.3.5 If the Contractor desires to employ a method different from the above suggested methods, he shall furnish the details for approval.

3.8.3.6 After the pipe has been placed, boring operation trenches or pits shall be backfilled in layers not greater than 8 in (200 mm) compacted depth, with each layer thoroughly compacted. Any surplus material shall be disposed of as required.

3.9 Removal of Pipe for Relaying.

3.9.1 Pipes shall be removed in accordance with 202.3.3 and 107.09.

3.9.2 Any pipe damaged shall be replaced with like material.

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3.9.3 Any additional pipe needed shall be of like material.

3.10 Pipe Bored or Jacked.

3.10.1 When pipe other than pipe sleeve is to be bored or jacked, specifications governing the materials and construction requirements will be provided in the proposal.

Method of Measurement

4.1 Pipe will be measured by the linear foot (linear meter) to the nearest foot (0.1 meter). Measurement of circular pipe will be made between the ends of the pipe along the central axis as installed. In the case of pipe-arches, the length will be measured along the invert. In the case of twin pipes and other multiple pipe structures, each barrel will be measured separately.

4.2 End sections will be measured by the number of units installed.

Basis of Payment

5.1 The accepted quantities of pipe will be paid for at the contract unit price per linear foot (linear meter) of the kind, type, and size specified complete in place, including common structure excavation up to the depth specified in 206.4.1, secondary excavation required in the imperfect trench method, bedding, and backfill, with the following stipulations:

5.1.1 All rock structure excavation, any common structure excavation below the depth specified in 206.4.1, and excavation of unsuitable material required below the bottom of the pipe, will be paid as provided in 206. Bottom of pipe is defined in 5.1.1.1.

5.1.1.1 The term "bottom of pipe" for concrete pipe shall mean the nominal manufactured thickness of the wall below the flow line, with nothing extra for bells of bell and spigot pipe; such term when used with metal pipe shall be considered to be the same elevation as the flow line.

5.1.2 When the depth of excavation for a pipe is increased more than 1 ft (300 mm) by lowering the grade or changing the location from that shown on the plans, or when pipes are ordered in addition to those shown on the plans, additional excavation will be paid as provided in 206 in accordance with 206.4.1.1(2).

5.1.3 Granular backfill, when ordered, will be paid as provided in 209.

5.2 End sections of the kind and size specified will be paid for at the contract unit price each complete in place.

5.3 The cost of furnishing and installing additional pipe for laying or relaying pipe, required through no fault of the Contractor, will be paid as provided in 109.04 unless a bid item therefore is included in the contract.

5.4 When pipe is bored or jacked, no extra allowance will be made for excavation or backfill for the pipe or for any jacking pits. Any damage to the existing roadway shall be repaired at the Contractor's expense.

5.5 Temporary diversion of water including trenching or pumping directly from the trench or sumps shall be subsidiary to the culvert installation. When well points or other specific dewatering devices are required or ordered, they will be paid as shown or as provided in 109.04.

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5.6 When deflection verification testing is ordered by the Engineer, all costs associated with this testing will be paid by the Contractor, unless the deflection is 5 percent or less for a complete run of pipe. When deflection is 5 percent or less, the Contractor will be reimbursed for all costs associated with the testing, as extra work, for all continuous runs of pipe found to be acceptable.

5.7 Concrete class F, flowable fill substituted for backfill material shall be subsidiary to the pipe item.

KEY TO ITEM NUMBERS FOR PIPES

Item Number	Unit
603 .A B C D E	Item Number
603 .A	Section Number
B	Material or Use
Class, Thickness, or Other	Type of Material
D E	Diameter or Span Rounded to Nearest Inches (or 100 mm)
.0 Reinforced Concrete Pipes	Linear Foot (Linear Meter)
0 Circular	
1 Arch	
2 Blank	
3 Blank	
4 Blank	
C Class	
1 1500 D (Class II)	
2 2000 D (Class III)	
3 3000 D (Class IV)	
4 3750 D (Class V)	
5 4000 D (200 kPa)	
6 5000 D (250 kPa)	
.1 Metal Pipes	Linear Foot (Linear Meter)
1 Corrugated Steel	
2 Corrugated Aluminum	
3 Corrugated Aluminized Steel (Type 2)	
4 Reserved	
5 Corrugated Steel Pipe-Arch	
6 Corrugated Aluminum Pipe-Arch	
8 Corrugated Steel Slotted Drain Pipe	
C Thickness in Inches (Millimeters)	
Steel Aluminum	
0 0.064 (1.63) 0.060 (1.52)	
2 0.079 (2.01) 0.075 (1.91)	
4 0.109 (2.77) 0.105 (2.67)	
6 0.138 (3.51) 0.135 (3.43)	
8 0.168 (4.27) 0.164 (4.17)	

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603	.A	B	C	D	E	Item Number
603						Section Number
	.A					Material or Use
		B				Type of Material
			C			Class. Thickness. or Other
				D	E	Diameter or Span Rounded to the Nearest Inch (100 mm)
.2	Pipe Sleeves					Linear Foot (Linear Meter)
0	Unspecified					
1	Reinforced Concrete					
2	Corrugated Steel					
3	Corrugated Aluminum					
4	PVC Plastic					
.3	End Sections					Each
0	Reinforced Concrete					
3	Polyethylene					
4	Steel					
5	Aluminum					
9	Resetting Metal Pipe End Section					
.4	Pipe for Slope Drainage					Linear Foot (Linear Meter)
2	Corrugated Steel					
3	Corrugated Aluminum					
0	Unspecified					
1	Corrugated Steel					
.5	Pipe for Drives and Minor Approaches					Linear Foot (Linear Meter)
0	Unspecified					
.6	Laying or Relaying Drainage Pipe (Furnished by the State or Salvaged)					Linear Foot (Linear Meter)
0	Unspecified					
1	Reinforced Concrete					
2	Corrugated Steel					
3	Corrugated Aluminum					
.7	Pipe, Jacked or Bored					Linear Foot (Linear Meter)
1	Reinforced Concrete under Roadbed					
2	Reinforced Concrete under Railroad					
C	Strength: Refer to Col. "C" under 603.0					
3	Blank					
4	Blank					
C	Thickness: Refer to Col. "C" under 603.1					
.8	Plastic Pipe					Linear Foot (Linear Meter)
1	PVC Pipe					
2	Polyethylene Pipe					
1	Corrugated Interior					
2	Smooth Interior					
3	Plastic Pipe					

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Examples (ENGLISH):

603.00215	15" Reinforced Concrete Pipe, 2000 D	
603.20004	4" Pipe Sleeve	
603.49012	12" Pipe for Slope Drainage\	Linear Foot
603.44012	12" Corrugated Polyethylene Pipe for Slope Drainage	Linear Foot
603.60012	Relaying 12" Drainage Pipe	
603.831__	__" Plastic Pipe (Corrugated Interior)	Linear Foot
603.832__	__" Plastic Pipe (Smooth Interior)	Linear Foot
603.332__	__" Polyethylene End Section	Each
603.690 __ _	" Drainage Pipe	Linear Foot

Examples (METRIC):

603.00204	375 mm Reinforced Concrete Pipe, Class III	
603.20001	100 mm Pipe Sleeve	
603.49003	300 mm Pipe for Slope Drainage	
603.44003	300 mm Corrugated Polyethylene Pipe for Slope Drainage	Linear Meter
603.6003	Relaying 0 to 300 mm Drainage Pipe	
603.8310_	__ mm Plastic Pipe (Corrugated Interior)	Linear Meter
603.8320_	__ mm Plastic Pipe (Smooth Interior)	Linear Meter
603.3320_	__ mm Polyethylene End Section	Each
603.6900_	__ mm Drainage Pipe	Linear Meter

SECTION 604 -- CATCH BASINS, DROP INLETS, AND MANHOLES

Description

1.1 This work shall consist of furnishing and constructing catch basins, drop inlets, and manholes; with frames, grates or manhole covers; as shown on the plans or as ordered. Common structure excavation to the depth specified in 206.4.1, bedding if required, and backfill shall be included in this work.

1.2 This work shall consist of reconstructing, including adjusting, existing catch basins, drop inlets, and manholes as shown on the plans or as ordered.

1.3 This work shall also consist of furnishing and installing frames, grates or manhole covers; as shown on the plans or as ordered.

1.4 Surfaces of existing drainage structures shall be completely coated with water repellent on the inside above the flow line unless directed otherwise.

Materials

2.1 Precast concrete sections shall conform to AASHTO M 199 (AASHTO M 199M). The concrete shall be Class AA, meeting the requirements of 520 except as noted herein.

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2.2 Reinforcing shall be steel, or structural fibers. Steel shall conform to the requirements of 544. Fibers shall only be utilized in structures with 4 feet (1.2 meters) or less inside diameter and shall be as shown on the NHDOT Qualified Products list.

2.3 Precast concrete sections shall conform to AASHTO M 199 (AASHTO M 199M). The concrete shall be Class AA, meeting the requirements of 520 except as noted herein.

2.3.1 Except for components cast using the dry cast process, precast concrete components shall not have the forms removed until a minimum compressive strength of 2000 psi (15 Mpa) has been achieved. Once initial set of the concrete has occurred, precast components shall not be moved until a minimum compressive strength of 2000 psi (15 Mpa) has been achieved. Concrete cylinders shall be made, in accordance with AASHTO T 23, at the last placement of the day.

2.3.2 Curing of precast sections.

2.3.2.1 All precast concrete units shall be coated with a white pigmented curing compound before being stored outside. The membrane curing compounds used under this method shall be Type 2 (white pigmented) Class B conforming to AASHTO M 148 and must appear on the Department's current Qualified Products List. The compound shall be properly agitated immediately before each use. A minimum coverage rate of 1 gallon per 200 square feet (two liters per 10 square meters) shall be used.

2.3.2.1.1 Where concrete is to be bonded with fresh concrete or coatings applied, curing compound shall be removed.

2.3.2.2 Prior to placement of the curing compound, all precast concrete units shall be subjected to curing by any one of the methods described below. The manufacturer shall provide minimum/maximum temperature thermometers to monitor curing temperatures unless otherwise specified. If, at any time, curing temperatures fall below the specified minimum for the chosen curing method, the curing period shall be increased accordingly. No unit shall be subjected to freezing temperatures until eighty percent of the specified 28 day compressive strength has been reached.

2.3.2.3 Units which are exposed to freezing before reaching the required 28 day compressive strength may require additional testing for compressive strength, as directed by the Materials and Research Bureau. Additional testing, when required, will be performed on cores taken from the hardened concrete.

2.3.2.4 Steam Curing. The units shall be cured in a suitable enclosure as approved by the Bureau of Materials and Research. The enclosure shall be designed to minimize the loss of heat and moisture while allowing for the uniform circulation of steam around the entire unit. The interior surfaces of the enclosure and the surface of the unit shall be moist at all times. Steps shall be taken to prevent localized "hot spots" caused by the steam lines. The enclosure shall be free from outside drafts.

2.3.2.4.1 Steam curing shall not begin until a preset period has been completed. The preset period begins when the last concrete has been placed and continues until the concrete obtains initial set. Prior written approval from the Bureau of Materials and Research is required when preset periods of less than two hours are to be used.

2.3.2.4.2 During the preset period, moderate heat may be applied to the enclosure to maintain the initial temperature of the concrete. The maximum temperature inside the enclosure during the preset period shall be the initial temperature of the concrete, plus 9° F (5 ° C).

2.3.2.4.3 After the preset period is complete, steam shall be injected into the curing enclosure. The temperature inside the enclosure shall not be increased at a rate greater than 36 degrees F (20° C) per

hour. A moist atmosphere will be maintained at a temperature between 104 degrees F (40° C) and 185 degrees F (85° C) for a period of not less than 12 hours. The temperature inside the enclosure shall then be decreased at a rate not exceeding 36 degrees F (20° C) per hour until the ambient temperature outside the enclosure is reached. The manufacturer shall provide automatic temperature recorders to continuously record the curing temperature inside the enclosure. The concrete strength shall be determined by testing cylinders cured in the same environment as the concrete they represent.

2.3.2.5 Water Spray Curing. Curing shall begin as soon as the concrete has hardened sufficiently to prevent surface damage from the water spray. All exposed surfaces of the precast unit shall be kept wet with a continuous fine spray of water in an enclosure maintained at a temperature of not less than 68 degrees F (20° C) for 72 hours or until 80% of the 28 day compressive strength is reached. The concrete strength shall be determined by testing cylinders cured using the water spray method and kept in the same environment as the concrete they represent.

2.3.2.6 Saturated Cover Curing. The saturated covers used under this method shall be burlap, meeting the requirements of 520.2.6.1. Curing shall begin as soon as the concrete has hardened sufficiently to prevent surface damage from the saturated burlap. All exposed concrete surfaces on the precast unit shall be covered with burlap, saturated with water before applying. The burlap will be kept saturated and the units kept at a temperature of not less than 68 degrees F (20° C) for 72 hours or until 80% of the 28 day compressive strength is reached. The concrete strength shall be determined by testing cylinders cured using the saturated cover method and kept in the same environment as the concrete they represent. Additional curing time may be necessary to meet the strength requirements.

2.3.2.7 Moisture Retention Curing. Units cured in accordance with these methods shall be maintained at a minimum temperature of 50 ° F (10° C) for 7 days or until 80% of the 28 day compressive strength has been reached. Additional curing time may be necessary to meet the strength requirements. The concrete strength shall be determined by testing cylinders cured in the same environment as the concrete they represent. Moisture retention curing shall be accomplished by either of the following 2 methods.

2.3.2.7.1 Membrane Curing Compound.

2.3.2.7.1.1 The membrane curing compound shall be applied to the concrete surface after finishing, as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the liquid curing compound will be absorbed into the concrete. When curing compound cannot be applied within the above requirements, the manufacturer shall instead immediately begin curing the unit in accordance with one of the other curing methods contained in this specification, until curing compound can be applied. When curing compound is to be used in conjunction with any other method of cure, the Engineer shall be notified prior to the start of production. When this method is used in conjunction with the dry cast process, the curing room shall be kept at 100% humidity until a minimum compressive strength of 2000 psi (15 Mpa) has been obtained.

2.3.2.7.1.2 When the forms are removed prior to 7 days, the exposed concrete surfaces shall be wet with water within one half hour of form removal and shall be kept wet until the curing compound is applied. Before application, the concrete shall be allowed to reach a uniformly damp appearance with no free water on the surface, and then the compound shall be applied immediately.

2.3.2.7.1.3 This method of curing shall not be used on any concrete surface that is to have plastic concrete bonded to it. Another approved method of curing shall be used when this condition exists.

2.3.2.7.2 Curing Covers.

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2.3.2.7.2.1 The curing covers used under this method shall conform to AASHTO M 171. Curing covers shall be placed immediately following the finishing operation or form removal, whichever is applicable. Care shall be taken not to damage any exposed concrete surfaces during cover placement. Curing covers shall be placed and secured and be of such condition as to minimize the loss of moisture and temperature. When it is necessary to use more than one curing cover, the edges shall be lapped a minimum of 12 inches (300 mm).

2.4 Clay brick shall conform to the requirements of AASHTO M 91, Grade MS. The use of concrete brick will not be permitted.

2.5 Concrete masonry units shall conform to the requirements of ASTM C 139 and shall have a minimum compressive strength of 3,000 psi (20 Mpa) when tested by the method in AASHTO T 140.

2.6 Cement mortar shall conform to 707.

2.7 Castings shall be gray iron conforming to AASHTO M 105 and AASHTO M 306. Castings shall be proof load tested.

2.8 Steel grates shall be of structural steel conforming to AASHTO M 183M/M 183 ASTM A 36/A 36M. The grates shall be fabricated as shown on the plans or approved. All top edges shall be flush, and all rivets shall be tight and properly headed. After fabrication, the grates shall be galvanized in accordance with AASHTO M 111 or ASTM A 153 as applicable.

2.9 Prefabricated adjustment rings for catch basins, drop inlets and manholes shall conform with 2.7 or as shown on the Qualified Products List.

2.10 Polyethylene material shall conform to the requirements of ASTM M 294, Section 6.0, but not have a wall thickness less than 1/4 in (6 mm).

Construction Requirements

3.1 Concrete construction shall conform to the requirements for structural concrete. Masonry shall conform to the requirements for the respective type. Joints shall be full mortar joints not more than 1/2 in (13 mm) wide. Exposed joints shall be neatly finished. Masonry shall fit neatly and tightly around the pipe.

3.1.1 Reinforced precast sections shall not be shipped from the manufacturing facility until the eighth day from the date of manufacture, except when the supplier provides test results demonstrating that the design strength has been achieved.

3.2 In accordance with the provisions of AASHTO M 105, 17.2, following are the “other matters of workmanship and finish” required: Frames and grates or frames and covers shall be matched before being incorporated in the work. Grates and covers shall make full and even bearing on the underlying surface to fit into the frames without rocking.

3.3 When reconstruction or adjustment of existing structures is specified, the frames and grates or covers shall be removed and the walls reconstructed as required. The frames and grates or covers shall be cleaned and reset at the required elevation.

3.3.1 Prefabricated adjustment rings may be used and shall be installed in accordance with the manufacturer’s recommendations.

3.4 Structures within the limits of bituminous concrete pavement shall be temporarily set at the elevation of the bottom of the binder course or as ordered. After the binder course has been compacted, these structures shall be set at their final grade. Backfill necessary around such structures after the binder course has been completed shall be made with Class AA concrete unless otherwise ordered.

3.5 Upon completion, each structure shall be cleaned of silt debris, or other matter of any kind and shall be kept clean until Acceptance of the Work.

3.6 Excavation and backfill shall conform to 206.3.

3.7 Sewer manholes constructed or reconstructed shall be tested after all connections have been made according to the requirements of the Department of Environmental Services, Water Division.

3.8 Surface preparation for drainage structures to be treated with water repellent shall be sufficient to remove dust, dirt, oil, wax, other coatings, efflorescence and other foreign materials. All surfaces shall be dry prior to the application of water repellent.

3.8.1 Treatment shall be performed in accordance with the other applicable provisions of 534.

3.9 Polyethylene liners shall be manufactured and installed in accordance with the standard plans.

Method of Measurement

4.1 Catch basins, drop inlets, and manholes will be measured from the bottom of the metal frame or concrete cover to the top of the base.

4.2 Reconstructing, or adjusting, catch basins, drop inlets, or manholes will be measured by the linear foot (linear meter), vertically to the nearest 0.1 of a foot (meter), between the bottom of the metal frame or concrete top and the top of the undisturbed portion of the existing structure.. A minimum of 1 foot (0.3 m) of reconstructing will be paid for each structure measured.

4.3 Frames with grates or manhole covers will be measured by the number of units installed except when they are a part of a structure measured under 4.1. A cover and frame will be a unit, and a grate and frame will be a unit.

4.4 Water repellent for existing drainage structures will be measured by the each for the number of drainage structures ordered to be treated.

4.5 Polyethylene liners will be measured by number of each installed.

Basis of Payment

5.1 The accepted quantities of catch basins, drop inlets, and manholes, which includes the necessary frames and grates or covers, of the type and diameter specified will be paid for at the contract unit price per unit complete in place, including common structure excavation and setting to final grade to the depth specified in 206.4.1, bedding if required and backfill with the following stipulations:

5.1.1 For catch basins and manholes other than special catch basins and manholes, up to the first 8 ft (2.5 m) will be paid for as one unit. Any additional depth required will be paid by dividing the additional depth by the 8 ft (2.5 m) unit depth. Payment will be to the nearest tenth of a unit.

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5.1.2 For drop inlets other than special drop inlets, up to the first 5 ft (1.5 m) will be paid for as one unit. Any additional depth required will be paid by dividing the additional depth by the 5 ft (1.5 m) unit depth. Payment will be to the nearest tenth of a unit.

5.1.3 Payment for structures indicated as “special” will be made by the complete unit of the depth shown on the plans. When an increase of 6 in (150 mm) or greater is ordered from the depth shown, the unit depth will be adjusted in proportion that the constructed depth, measured to the nearest foot (meter), bears to the depth shown on the plans. The proportion will be computed to no more than 2 decimal places.

5.1.4 All rock structure excavation, any common structure excavation below the depth specified in 206.4.1 and excavation of unsuitable material below the bottom of the catch basin, drop inlet, and manhole will be paid as provided in 206. Over excavation for bedding purposes in ledge and backfill for said over excavation will be subsidiary.

5.1.5 No extra allowance will be made for structures constructed in accordance with 3.4.

5.1.6 Water repellent treatment for new drainage structures will be subsidiary.

5.2 The accepted quantities of reconstructed catch basins, drop inlets, and manholes will be paid for at the contract unit price per linear foot (linear meter) complete in place, including reinstalling existing frames and grates or covers.

5.2.1 No payment will be made for reconstructing portions of the above structures which are unnecessarily disturbed.

5.2.2 No separate payment will be made for excavation for reconstructing the above structures.

5.3 The accepted quantities of frames and grates or manhole covers will be paid for at the contract unit price per each unit complete in place, including setting to final grade.

5.4 Testing of sewer manholes required in 3.7 will be subsidiary.

5.5 The accepted quantities of water repellent for existing drainage structures will be paid for at the contract unit price per each complete structure.

5.5.1 No separate payment will be made for surface preparation.

5.6 The accepted quantities of polyethylene liner will be paid at the contract unit price per each installed complete in place.

Pay items and units:

604.0007	Polyethylene Liner	Each
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KEY TO ITEM NUMBERS FOR CATCH BASINS, DROP INLETS AND MANHOLES

Item Number	Unit
604 .A B C	Item Number
604	Section Number
.A	Structure Type

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B	Grate and Frame Type Diameter	Unit
C		
.1	Catch Basins Type____,____ft (____m) Diameter	Unit
	1 Type A	
	2 Type B	
	3 Type C	
	4 Blank	
	5 Type E	
	6 Type F	
	8 With Frames and Grates Furnished by Others	
	9 Special	
.2	Drop Inlets Type____,____ft (____m) Diameter	Unit
	1 Type A	
	2 Type B	
	3 Type C	
	4 Type D-	
	5 Type E	
	6 Type F	
	8 With Frames and Grates Furnished by Others	
	9 Special	
.24	Drop Inlets D-____	Unit
	1 Type A	
	2 Type B	
	3 Blank	
	4 Blank	
	5 Type E	
	6 Type F	
.3	Manholes	Unit
	1 Sewer Manholes,____ft (____m) Diameter	
	2 Drainage Manholes,____ft (____m) Diameter	
	9 Special	
.4	Reconstructing/Adjusting Catch Basins and Drop Inlets	Linear Foot (Linear Meter)
.5	Reconstructing/Adjusting ____Manholes	Linear Foot (Linear Meter)
	1 Sewer	
	2 Drainage	
	3 Electrical	
	4 Telephone	
.6	____Manhole Covers and Frames	Each
	1 Sewer	
	2 Drainage	
7	Grates and Frames, Type____	Each
	1 Type A	
	2 Type B	
	3 Type C	

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- 4 Blank
- 5 Type E
- 6 Type F

.85 Water Repellent For Existing Catch Basins
and Drop Inlets

Each

Examples (ENGLISH):

- 604.126 Catch Basin Type B, 6 ft Diameter
- 604.226 Drop Inlet Type B, 6 ft Diameter
- 604.242 Drop Inlet Type D-B
- 604.326 Drainage Manholes, 6 ft Diameter
- 604.51 Reconstructing Sewer Manholes

Examples (METRIC):

- 604.1218 Catch Basin Type B, 1.8 m Diameter
- 604.2218 Drop Inlet Type B, 1.8 m Diameter
- 604.242 Drop Inlet Type D-B
- 604.3218 Drainage Manholes, 1.8 m Diameter
- 604.51 Reconstructing Sewer Manholes

SECTION 605 -- UNDERDRAINS

Description

1.1 This work shall consist of furnishing (unless pipe is provided) and installing underdrains at the locations shown or ordered. Pipe, common structure excavation, support membrane, graded aggregate, sand cushion, and backfill where specified shall be included in this work.

1.1.1 Furnishing and installing underdrain flushing basins as shown on the plans or ordered shall also be included in this work.

1.2 Aggregate underdrain shall consist of furnishing and installing support membrane, graded aggregate, pipe, if ordered, common structure excavation, and backfill as necessary.

Materials

2.1 Perforated corrugated steel pipe and coupling bands shall conform to the applicable requirements of AASHTO M 36/M 36M, Type III. The minimum allowable metal thickness of 6 in (150 mm) underdrain pipe shall be (0.052 in (1.32 mm) ; the minimum allowable metal thickness in underdrain pipe larger than 6 in (150 mm) shall be 0.064 in (1.63 mm).

2.2 Perforated corrugated aluminum pipe and coupling bands shall conform to the applicable requirements of AASHTO M 197/M 197M.

2.3 Smooth-wall perforated and unperforated polyvinyl chloride pipe, bends and cleanouts shall conform to AASHTO M 278. Perforated polyvinyl chloride profile wall pipe shall conform to AASHTO M 304.

2.3.1 Basis of acceptance and test requirements of polyvinyl chloride pipe shall conform to AASHTO M 278 or AASHTO M 304 for the respective type of pipe. Only approved manufacturers will be allowed to furnish plastic pipe. The approved list and the approval criteria can be obtained from the Bureau of Materials and Research. A certificate of compliance, as required by 106.04, shall be provided for each shipment.

2.4 Polyethylene drainage tubing 6 in (150 mm) in diameter shall conform to AASHTO M 252, Type S, with either Class 1 or Class 2 perforations. Perforated corrugated polyethylene pipe of nominal sizes 12 to 36 in (300 to 900 mm) diameter shall conform to AASHTO M 294, with Class 1 perforations. Lengths for all sizes shall not exceed 20 ft (6 m). Only approved manufacturers, as included on the Qualified Products List, shall be allowed to furnish plastic pipe.

2.4.1 Basis of acceptance and test requirements of polyethylene pipe shall conform to AASHTO M 252 or AASHTO M 294 for the respective type of pipe. The approval criteria can be obtained from the Bureau of Materials and Research. A certificate of compliance, as required by 106.04, shall be provided for each shipment.

2.5 Pipe Underdrain, Materials Per Contractor's Option.

2.5.1 When the item reads 6 in (150 mm) pipe underdrain (contractor's option), it shall be the Contractor's option whether he furnishes perforated corrugated steel pipe, perforated corrugated aluminum pipe, perforated polyvinyl chloride pipe or perforated corrugated polyethylene drainage tubing.

2.6 Sand cushion shall be so graded that 90 to 100 percent by weight will pass a 1/2 in (12.5 mm) sieve, and not more than 15 percent will pass a No. 200 (0.075 mm) sieve.

2.7 Underdrain backfill shall meet the requirements of 209.2.1.

2.8 Molded pull boxes for underdrain flushing basins shall conform to 614.2.6.

2.9 Aggregate for aggregate underdrain shall conform to 703, AGGREGATES, TABLE 1, STANDARD SIZE #4.

2.10 Support membrane shall be non-woven geotextile and conform to Item 593.131 - Geotextile, Subsurface Drainage, Class 3, Non-woven.

Construction Requirements

3.1 Trenches shall be excavated to the dimensions and grade shown or ordered. A minimum 2 in (50 mm) sand cushion in common excavation and a 6 in (150 mm) sand cushion in rock excavation shall be placed in the bottom of the trench for its full width and length to the grade of the bottom of the pipe.

3.2 Perforated pipe shall normally be placed with the perforations down, and sections shall be securely joined with the appropriate couplings, fittings, or bands.

3.3 After the pipe installation has been inspected and approved, underdrain backfill material shall be placed to a height of 12 in (300 mm) above the top of the pipe, care being taken not to displace the pipe. The remainder of the backfill material shall then be placed to the required height and compacted in lifts not to exceed 12 in (300 mm).

3.4 Pipes shall be laid with 45 degree bends where changes in direction are indicated on the plans.

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3.5 Except at structures, up grade ends of all underdrain pipe installations shall be closed with suitable plugs to prevent entry of soil material.

3.6 Flushing Basins.

3.6.1 Flushing basins shall be installed approximately 2 ft (600 mm) beyond the break in the shoulder and in such manner as to allow the molded pull box to be set within the slope limits.

3.6.2 Any excavation required to install flushing basins shall be done in accordance with 3.1.

3.6.3 Additional 6 in (150 mm) unperforated pipe shall be added to the long 1/8 bend to bring the riser to the required elevation.

3.6.4 After the fitting and 6 in (150 mm) riser pipe installation has been inspected and approved, underdrain backfill material shall be placed and properly compacted to a height which will allow for the proper installation of the cleanout and molded pull box. The remainder of the backfill and base course necessary shall then be placed to the required height and compacted. Care shall be taken to prevent backfill material from entering the riser pipes.

3.7 Aggregate Underdrains.

3.7.1 Trenches shall be excavated to the dimensions shown or ordered. Type 1 aggregate underdrain shall have a 6 in by 10 foot (150 mm by 3 m) section of pipe at the outlet end of each section of underdrain. Type 2 shall include pipe of the specified diameter throughout.

3.7.2 Non-woven support membrane shall be installed so as to minimize the number of fabric seams within the trench section. Seams shall be constructed by overlapping the fabric at least 12 in (300 mm) and folding to create a joint which will ensure that soil infiltration will be retarded.

3.7.3 Aggregate shall be placed within the typical section as shown in a manner that will maintain the fabric integrity. Punctures created by aggregate, equipment, tools or improper handling shall be patched by placing fabric at least 12 in (300 mm) beyond the puncture limits on the outside of the typical section.

3.7.4 Pipe, as required, shall be laid to grade as ordered.

3.7.5 Backfill shall be placed and tamped in the areas outside and adjacent to the aggregate underdrain so that the shape of the typical is maintained. Sharp pieces of rock shall not be placed immediately adjacent to the fabric.

3.7.6 When rock is encountered, sharp projections of solid rock shall be removed within the typical section, primarily at the bottom of the trench.

Method of Measurement

4.1 Underdrains will be measured by the linear foot (linear meter) to the nearest 0.1 foot (meter) along the centerline of the pipe.

4.1.1 Aggregate underdrain will be measured by the linear foot (linear meter), to the nearest 0.1 of a foot (meter) along the centerline of the aggregate underdrain.

4.2 Backfill or cushioning material furnished will be subsidiary.

4.3 Underdrain flushing basins will be measured by the number of units installed.

4.3.1 Each unit shall include all required riser pipe, 45° wye, long bend, cross pipe, cleanout pull box and backfill material as required.

Basis of Payment

5.1 The accepted quantities of underdrain of the type specified will be paid for at the contract unit price per linear foot (linear meter) in place, including common structure excavation, sand cushion and backfill.

5.1.1 Payment will not be made for 45 degree bends.

5.1.2 Rock excavation will be paid for under Item 206.2.

5.2 The accepted quantity of underdrain flushing basins will be paid for at the contract unit price per each complete in place, including riser pipe, 45° wye, long bend, cross pipe, cleanout pull box, common structure excavation, and backfill.

5.3 The accepted quantities of aggregate underdrain of the type specified will be paid for at the contract unit price per linear foot (linear meter) in place, including support membrane, graded aggregate, pipe, if ordered, common structure excavation, and backfill.

5.3.1 Payment will not be made for fabric used for patching.

5.3.2 Rock excavation required will be paid for as provided in 5.1.2.

Pay items and units (ENGLISH):

605.1_	_in Perforated Corrugated Steel Pipe Underdrain	Linear Foot
605.4_	_in Perforated Polyvinyl Chloride Pipe Underdrain	Linear Foot
605.5_	_in Perforated Corrugated Polyethylene Pipe Underdrain	Linear Foot
605.79	Underdrain Flushing Basins	Each
605.81A	_in Aggregate Underdrain Type 1	Linear Foot
605.82ABC	_in Aggregate Underdrain Type 2, With _____ Pipe	Linear Foot
605.84015	1-1/2 in PVC Plastic Horizontal Drains	Linear Foot
605.906	6 in Pipe Underdrain (Contractor's Option)	Linear Foot

Notes:

A = Width of Underdrain

1 = 18" 2 = 24" 3 = 30" 4 = 36"

B = Type of Material

1 = Perforated Corrugated Steel
2 = Blank

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- 3 = Perforated Corrugated Aluminum
- 4 = Perforated Polyvinyl Chloride
- 5 = Perforated Corrugated Polyethylene

C = Diameter of Pipe

1 = 6" 2 = 12" 3 = 18" 4 = 24"

Examples:

- 605.82311 30 inch Aggregate Underdrain Type 2, with
Perforated Corrugated Steel 6 in Pipe
- 605.906 6 inch Pipe Underdrain (Contractor's Option)

Pay items and units (METRIC):

605.1_	_mm Perforated Corrugated Steel Pipe Underdrain	Linear Meter
605.4_	_mm Perforated Polyvinyl Chloride Pipe Underdrain	Linear Meter
605.5_	_mm Perforated Corrugated Polyethylene Pipe Underdrain	Linear Meter
605.79	Underdrain Flushing Basins	Each
605.81A	_mm Aggregate Underdrain Type 1	Linear Meter
605.82ABC	_mm Aggregate Underdrain Type 2 With _____ Pipe	Linear Meter
605.8404	40 mm PVC Plastic Horizontal Drains	Linear Meter
605.915	150 mm Pipe Underdrain (Contractor's Option)	Linear Meter

Notes:

A = Width of Underdrain

1 = 450 mm 2 = 600 mm 3 = 750 mm 4 = 900 mm

B = Type of Material

- 1 = Perforated Corrugated Steel
- 2 = Blank
- 3 = Perforated Corrugated Aluminum
- 4 = Perforated Polyvinyl Chloride
- 5 = Perforated Corrugated Polyethylene

C = Diameter of Pipe

1 = 150 mm 2 = 300 mm 3 = 450 mm 4 = 600 mm

Examples:

605.82311	750 mm Aggregate Underdrain Type 2, with Perforated Corrugated Aluminum 150 mm Pipe
605.915	150 mm Pipe Underdrain (Contractor's Option)

SECTION 606 -- GUARDRAIL**Description**

1.1 This work shall consist of furnishing and installing guardrail, anchorages, terminal units, concrete barriers, and pipe handrails of the type specified at the locations shown on the plans or as ordered.

1.1.1 Resetting of existing guardrail shall be included in this work.

1.1.2 Temporary guardrail, temporary concrete barrier, and temporary impact attenuators shall consist of furnishing, installing, maintaining, relocating and removing as specified.

1.2 This work shall also consist of furnishing and installing zinc inserts at all lap joint locations where corrosion resistant beam guardrail is used.

Materials**2.1 Wood Posts, Offset Blocks, and Rails.**

2.1.1 Wood posts shall be treated in accordance with 2.2, sound and reasonably straight. The ends shall be cut square or as indicated. Posts with hollow knots, open or plugged holes, or season checks exceeding 1/4 inch (6 mm) in width will be rejected.

2.1.1.1 Guardrail posts, offset blocks and wood rails shall be made of timber with a stress grade of 1,200 psi (8.3 MPa) or more for extreme fiber in bending in accordance with AASHTO M 168. All cuts and holes shall be made before preservative treatment.

2.1.1.2 Wood rails shall be treated in accordance with 2.2, straight and sound, free from loose knots and other defects, and shall be surfaced on all sides.

2.2 Preservative Treatment.

2.2.1 All wood posts and rails shall be treated with preservative materials conforming to the requirements of AASHTO M 133.

2.2.2 The type of treatment shall be one of the following:

Treatment	Minimum net retention, Pounds per cubic foot (Kilograms per cubic meter)
Type A Pentachlorophenol	0.60 (9.6) Dry Salts
Water-Borne Preservative	0.40 (6.4)

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2.2.3 All wood posts and rails shall be treated after sawing and drilling or retreated after drilling in accordance with AASHTO M 133.

2.3 Structural Shape Posts and Blocks.

2.3.1 Structural shape steel posts and blocks shall conform to ASTM A 36/A 36M and shall be galvanized after fabrication to meet the requirements of AASHTO M 111.

2.4 Rails and Fittings for Beam Guardrail.

2.4.1 Rails and fittings shall be as shown in the current edition *A Guide to Standardized Highway Barrier Hardware, AASHTO – AGC- - ARTBA Joint Cooperative Committee*. Galvanized steel rail elements, terminal sections, bolts, nuts, and other fittings shall conform to AASHTO M 180, (except that paragraph 11, Marking, shall not apply), Type II, Class A. Galvanized steel rail elements and terminal sections shall be treated with a solution of sodium dichromate or other approved chemical solutions so as to prevent or reduce storage stain. Corrosion resistant steel shall conform to AASHTO M 180, Type IV, Class A.

2.4.1.1 Miscellaneous steel hardware not shown in *A Guide to Standardized Highway Barrier Hardware, AASHTO – AGC- - ARTBA Joint Cooperative Committee* designation shall conform to ASTM A 36 and A 500 as appropriate. Hardware shall be galvanized, after all fabrication, in accordance with AASHTO M 232.

2.4.2 Steel rail elements shall be shop punched to allow for 6 foot – 3 inch (1905 mm) post spacing or as required. Where the rail is on a curve having a radius of 150 ft (45 m) or less, the rail shall be shop curved. The plates at the splice shall make contact throughout the area of the splice. Guardrail parts furnished under this specification shall be interchangeable with similar parts, regardless of the source of manufacture.

2.4.3 The post bolt and connection shall withstand a 5,000 lb (22 kN) pull in either direction.

2.5 Anchor blocks. Anchor blocks shall be as shown on the plans.

2.6 Permanent Concrete Anchors and Barriers.

2.6.1 Concrete shall be Class AA conforming to 520.1.2. The cement shall be Type III Portland cement as specified in AASHTO M 85. Slump shall be closely controlled between 2 and 3 inches (50 and 75 mm). Concrete used in extrusion or slip form barrier shall be of such consistency that after extrusion, it shall maintain the shape of the barrier without support.

2.6.1.1 Corrosion inhibitor admixture shall conform to AASHTO M 194 (ASTM C 494) Type C as included on the Qualified Products List.

2.6.2 Reinforcing steel shall conform to 544.

2.6.3 Structural material including end connectors shall conform to the applicable portions of 550.

2.6.3.1 Galvanizing shall conform to AASHTO M 111.

2.6.4 Mortar for patching, when permitted, shall be composed of the exact ingredients of the concrete with the coarse aggregate omitted.

2.6.5 Preformed Expansion Joint Filler shall conform to AASHTO M 153, Type III or AASHTO M 213.

2.6.6 Water repellent coating on concrete barrier, except portable concrete barrier for traffic control, shall be Silane-Siloxane conforming to 534.2.2.

2.7 Delineators. Delineators shall conform to 621.

2.8 Handrail.

2.8.1 Steel Pipe for rails and posts shall conform to ASTM A 53, Schedule 40, Standard Weight of the diameter shown on the details. Pipe shall be galvanized after fabrication in accordance with the requirements of AASHTO M 111.

2.8.2 Grout for anchoring the pipe posts shall be High Strength, Impact Resistant, Non-shrink Grout as included in Section 529 on the Qualified Products List.

2.9 Retroreflective sheeting shall conform to AASHTO M 268 (ASTM D 4956) minimum of Type III sheeting.

2.10 Blank

2.11 Inserts for corrosion resistant steel shall be made of zinc foil with a nominal thickness of 20 mils. They shall have holes shop punched and shall be shaped to conform to the dimensions as given in AASHTO M180, figure 1 for standard W beam, or figure 2 for thrie beam. Guardrail inserts shall be manufactured to a length of 12.5 inch (312 mm).

2.11.1 Zinc used for the manufacture of the inserts shall meet the requirements of ASTM B 6 Standard Specification for Zinc and shall also meet the requirements of ASTM B 69-Standard Specification for Rolled Zinc. The material shall be Special High Grade, with a minimum of 99.99% Zinc as shown in table 1 of ASTM B 6.

2.11.2 A certificate of compliance shall be supplied by the manufacturer certifying compliance with applicable specifications. In addition to the certificate of compliance the manufacturer shall also provide a certified chemical composition of the material.

2.12 Temporary Traffic Control

2.12.1 Temporary impact attenuation devices for traffic control shall be designed to meet the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350 at a minimum of Test Level 2 43.5 mph ([70 km/h]) or Test Level 3 62.1 mph ([100 km/h]) as specified in the item description.

2.12.1.1 Impact attenuation devices (redirective and Non-redirective) shall be a product as included on the Qualified Products List unless allowed per 2.12.1.2 or specifically specified in the contract.

2.12.1.2 Sand barrel arrays and water filled impact attenuators are not included on the Qualified Products List. The Contractor may elect to utilize either sand barrels or water filled attenuators for the non-redirective category with approval by the Engineer. The Contractor shall provide certification that the unit complies with the NCHRP 350 test level specified.

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2.12.2 Sand Barrel arrays and water filled impact attenuators shall be made up of modules. Modules shall be durable, weather proof and with outer components formulated to resist deterioration from ultra-violet rays.

2.12.2.1 Sand barrels and water filled arrays will not be allowed for use November 1st to April 15th unless they are at least ten feet away from the travelway (measured to the face) or specifically approved in writing by the Engineer. If approved by the Engineer for winter use, the sand or water shall be treated to prevent freezing.

2.12.2.2 When a project that is anticipated to be completed prior to November 1st, is delayed till the next season due to the Contractor's method of construction, it shall be the responsibility of the Contractor to replace sand barrel arrays with an impact attenuation device included on the Quality Products List, at no cost to the Department. When an extension of time is granted under 108.07 the additional cost for replacement will be paid in accordance with the provisions of 109.04.

2.12.3 Impact attenuation devices shall be redirective or non-redirective as specified in the item description. Redirective devices shall be capable of redirecting the impacting vehicle over the full length of the device.

2.12.4 Used impact attenuators, beam guardrail, and terminal units for traffic control barrier, in good operating condition, will be allowed with approval from the Engineer.

2.13 Temporary beam guardrail.

2.13.1 Temporary beam guardrail shall meet the requirements of Item 606.120 (steel posts) or Item 606.140 (wood posts).

2.13.2 Used beam guardrail and terminal units in good operating condition, will be allowed with approval from the Engineer.

2.14 Terminal Units.

2.14.1 Terminal unit EAGRT shall be an energy absorbing tangent type end unit as found on the Qualified Products List.

2.14.2 The same terminal unit EAGRT model shall be utilized throughout the project.

Construction Requirements

3.1 Posts.

3.1.1 Wood posts shall be set plumb at the required locations by either auguring, excavating or driving. Posts shall be set with butt ends down and without cutting the tops after treatment. The bottom of the holes shall be thoroughly tamped to grade. The face of the post nearest the road shall present a vertical line from the top to bottom.

3.1.2 Steel posts shall be driven to grade at the spacing required.

3.1.3 Post and anchor holes shall be backfilled with acceptable material placed in layers and thoroughly compacted with a power tamper.

3.1.4 The wood offset blocks shall be "toe nailed" to the rectangular wood posts to prevent them from turning.

3.1.1.1 Breakaway wood posts A and B shall be set in augured, pre-driven or hand dug holes and backfilled in accordance with 3.1.3.

3.2 Beam Rail.

3.2.1 Beam guardrail shall be erected to provide a smooth continuous rail conforming to the line and grade of the highway. Corrugated rail elements shall be lapped so that the exposed end of each element is away from approaching traffic. Tube-type beam elements shall be bolted and joined as shown on the plans. Expansion joint bolts shall be tightened, but not to a degree which will prevent the rail elements from sliding past each other longitudinally. All other bolts shall be drawn tight.

3.2.2 All metal work shall be fabricated in the shop. No punching, cutting, or welding shall be done in the field. Holes may be drilled or cutting done for special details only.

3.2.3 Galvanized beam rail shall be stored to prevent wet storage stain. Storage shall be off the ground and individual rail elements shall be separated with spacers to provide free access of air. The beam rail shall be inclined in a manner which will provide continuous drainage.

3.2.4 All damage to galvanized surfaces, threaded portions of all fittings and fasteners, and cut ends of bolts after assembly, shall be repaired by thoroughly wire brushing the damaged area and painting it with 2 coats of zinc-rich primer.

3.2.5 At each location where an electric transmission, distribution, or secondary line crosses any of the types of metal guardrail covered by these specifications, the guardrail shall be grounded as required by the electric utility company.

3.2.5.1 At locations where electric lines run parallel and in close proximity to metal guardrail, grounding systems may be required by the electric utility company.

3.2.6 All beam rail shall include retroreflectorized delineators, white or yellow, placed in accordance with the Standard Plans..

3.3 Terminal sections. Terminal sections shall be installed at each end of every installation of beam guardrail unless otherwise specified. Before installation, the Contractor shall provide the Engineer with copies of the manufacturer's documents indicating satisfactory testing in accordance with NCHRP 350 and/or its subsequent revisions and of the approval by the FHWA for use of the terminal unit as intended. The Contractor shall provide a list of component parts to the Engineer to be forwarded to the appropriate maintenance office.

3.3.1 Terminal units or sections shall be installed as shown on the plans, specified by the manufacturer or ordered.

3.3.2 Type III retroreflective sheeting shall be applied to the approach nose after fabrication and assembly but prior to the installation of bolts, if terminal units are installed less than 6 feet (1.8 meters) from the edge of pavement as follows:

One-Way Roadways:	Retroreflective yellow with black stripes sloping downward at an angle of 45 degrees toward the roadway on both sides of the roadway. The width of the stripes shall be 3 inch (75mm). Two-Way Roadways: Same as One-Way Roadway except the reflective sheeting is to only be placed on the right side of the roadway with no sheeting on the left side of roadway..
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3.3.2.1 Retroreflective sheeting on ELT terminal units shall be 12 in (300 mm) high x 24 inch (600 mm) wide and shall be attached to the 24 inch (600 mm) corrugated steel pipe 4 in (100 mm) down from the top by applying the retroreflective sheeting to 0.080 inch (2 mm) thick, 12 in x 24 inch (300 x 600 mm) aluminum sheet which shall be attached with six M6 – 1/4 inch – 20 x 1 inch (1.25 x 25 mm) bolts with, lock washers and nuts fastened on the top, middle and bottom edges.

3.3.2.2 Retroreflective sheeting on flat-ended terminal units shall be a minimum of 12 in (300 mm) wide and 24 in (600 mm) high unless the dimensions of the flat end surface of the terminal unit are less. In the case of the width being less than 12 in (300 mm) it shall cover the entire width of the flat surface. In the case of the height being less than 24 in (600 mm) it shall cover the entire height of the flat surface. If the 12 in (300 mm) wide sheeting does not cover the full width of the flat surface, the sheeting shall be placed on the roadway edge of the of the terminal unit. If the 24 in (600 mm) high sheeting does not cover the full height of the flat surface, the sheeting shall be placed from the top down.

3.4 Wood rail. Wood rail shall be constructed as shown on the plans. Wood surfaces cut or damaged shall be brush treated with 2 applications using material of the same specification as that used in the preservative treatment.

3.5 Resetting. The existing guardrail including anchorages shall be dismantled in a careful manner that eliminates damage and suitably stored. Unless otherwise ordered, hardware and fittings shall be packed in substantial containers. New treated posts shall be substituted for all existing untreated posts. Material damaged due to the Contractor's negligence shall be replaced with new materials at the Contractor's expense.

3.6 Temporary Impact Attenuators and Temporary beam guardrail.

3.6.1 Temporary Impact Attenuators for Traffic Control

3.6.1.1 Submit technical data to the Engineer for approval prior to installing the attenuator. This data shall include the overall length, width, the number of bays or modules, connection details, the point at which redirection is provided (where length of need is established on the device), the performance category (redirective or non-redirective), maximum design speed and the NCHRP test level the attenuator was tested to.

3.6.1.2 All work relating to the placement of the components of the impact attenuation device including transition sections shall be as shown on the manufacturer's details and shall be approved by the Engineer. Installation shall be in accordance with the manufacturer's recommendations.

3.6.1.3 The impact attenuation device shall be located on a concrete pad or prepared base as recommended by the manufacturer.

3.6.1.4 Provide a positive connection between the end of concrete barrier or guardrail and the impact attenuation device as recommended by the manufacturer.

3.6.1.5 Any device or device components damaged during installation shall be replaced with new parts from the manufacturer at the contractor's expense.

3.6.1.6 The Contractor shall have on hand one-replacement parts kit as recommended by the manufacturer for each unit prior to being installed.

3.6.1.7 Impact attenuators for traffic control shall remain the property of the Contractor and they shall be removed when the project is complete or they are no longer needed.

3.6.2 Damaged temporary beam guardrail, or temporary impact attenuators shall be repaired within 24 hours after notification by the Engineer.

3.6.3 Temporary beam guardrail shall be installed meeting the requirements of Item 606.120 (steel posts) or Item 606.140 (wood posts) except that approved used material may be installed.

3.7 Concrete Barriers.

3.7.1 General.

3.7.1.1 Concrete barriers shall be supplied as precast units or constructed cast-in-place as specified to the configuration and details shown on the plans. Portable concrete barrier for traffic control shall be precast units. Minor deviations in the shape shall be submitted to the Engineer for approval.

3.7.1.1.1 Concrete barrier shall conform to the following tolerances:

- A. Cross-sectional dimensions shall not vary from the dimensions specified by more than 1/4 inch (6 mm) and shall not be out of plumb by more than 1/4 inch (6 mm), except the base which shall not vary by more than 1/2 inch (13 mm).
- B. Longitudinal dimensions shall not vary from the dimensions specified by more than 1/4 in. (6 mm) per 10 ft (3.0 m).
- C. Surface straightness irregularities when checked with a 10 ft (3.0 m) straight edge shall not exceed 1/4 inch (6 mm).
- D. Bar Reinforcement cover shall not vary from the dimensions specified by more than 1/2 inch (13 mm).

3.7.1.2 Sections of barrier shall be uniform in color and in good condition, free from cracked or spalled surfaces.

3.7.1.3 The layout and placement of the concrete barriers shall be to the alignment and elevations shown on the plans or as directed. Before any concrete or precast barrier may be placed, the subbase shall be compacted to 95% density in accordance with the applicable tests as specified in 304.3 and fine graded to a tolerance of $\pm 1/2$ inch (13 mm) of the true grade at any location under the barrier. Whenever possible, as determined by the Engineer, concrete placing operations shall not begin until the subbase has been fine graded ahead at least 1,000 ft (300 m).

3.7.1.4 All concrete barriers shall include retroreflectorized delineators, white or yellow, placed in accordance with the Standard Plans.

3.7.1.5 Concrete shall contain corrosion inhibitor (calcium nitrate) admixture added at the rate of 4 gallons per cubic yard (20 liters per cubic meter).

3.7.1.6 Form work shall be in accordance with 520.3.2, externally braced in like new condition without any projections or depressions which would detract from the required finish. Proper care and precautions shall be exercised in removing forms to ensure no damage results to the finished surface of the barrier.

3.7.1.7 Reinforcing steel shall be placed in accordance with 544.

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3.7.1.8 Concrete Class AB in accordance with 520 may be substituted for aggregate base course and hot bituminous pavement in the patching on the roadway side of concrete barrier. Concrete thickness shall be not less than that of the adjacent pavement.

3.7.1.9 Concrete barrier, except portable concrete barrier for traffic control, shall receive a Class 1, Ordinary Finish in accordance with 520.3.12.

3.7.1.10 Water repellent (silane-siloxane) shall be applied to concrete barrier, except portable concrete barrier for traffic control, in accordance with 534.3.

3.7.1.11 Defects are divided into two categories, minor defects and major defects. Minor defects in the barrier may be repaired in the field. Major defects shall be cause for rejection of the section, or the section shall be repaired in the manner directed by the Engineer.

3.7.1.11.1 Minor defects are defined as holes, honeycombing or spalls which are 6 inch (150 mm) or less, in diameter, and which do not expose the outermost surface of the steel reinforcement. Surface voids 3/8 inch (10 mm), or less, in diameter and 3/8 inch (10 mm), or less, in depth are not considered defects and they do not require repair.

3.7.1.11.2 Major defects are defined as, any defect which does not meet the definition of a minor defect or minor defects which, in aggregate, comprise more than 2% of the surface area of the barrier section.

3.7.1.12 Repair of hardened concrete shall be as follows:

A. Minor Defect Repair. Repair shall be made with a Fast Set Non-shrink Patching Mortar appearing on the Qualified Products List. Methods of repair shall be acceptable to the Engineer. The color of the repaired portion shall match as nearly as practicable, the color of the surrounding concrete. Repaired portions shall exactly match shape requirements.

B. Major Defect Repair. Major defect repair methods shall be pre-approved by the Engineer.

3.7.2 Cast-in-Place Barriers. Cast-in-place barriers shall be constructed by either the “fixed forms” or “extrusion or slip form” method or a combination, at the Contractor’s option.

3.7.2.1 General.

3.7.2.1.1 Contraction joints shall be formed or saw cut normal to the pavement. The spacing shall be every 20 ft (6 m), as shown on the plans or as ordered by the Engineer. The joints shall conform to the dimensions as shown on the plans or standard sheets. If the joints are saw cut, they shall be saw cut so no damage to the concrete will result, within a maximum time of 8 hours. If sawing or forming joints is performed before the concrete has hardened, the adjacent portions of the barrier shall be supported firmly with close fitting shields. The liquid curing compound, if used, shall be reapplied at the saw cut.

3.7.2.1.2 Expansion joints shall be formed normal to the pavement with Preformed Expansion Joint Filler and shall provide for expansion of 1/2 in. (13 mm). The filler material shall be cut to conform to the cross section of the barrier.

3.7.2.1.2.1 The expansion joints shall be located at all immovable objects (bridge substructures, etc.), where shown on the plans, and/or as directed by the Engineer. Expansion joints shall not be required at regular intervals unless shown on the plans.

3.7.2.2 Fixed Forms Barrier.

3.7.2.2.1 Forms and subbase shall be thoroughly moistened in conformance to 520.3. Care shall be taken that form construction has been completed, embedment of required materials placed and removal of all foreign materials completed before the concrete is placed.

3.7.2.2.2 Concrete shall be placed in its final position. Excessive movement of concrete by use of vibrators will not be permitted.

3.7.2.2.3 Concrete shall not be dropped a distance of more than 5 ft (1.5 m) unless contained within a tremie, elephant trunk or other approved system.

3.7.2.2.4 Concrete shall be consolidated as provided in 520.3.5.4 by means of high frequency internal vibrators within 15 minutes after it is deposited in the forms. Vibrators shall not be attached to, or held against the forms or the reinforcing steel. Care shall be taken to avoid the displacement of reinforcement.

3.7.2.2.5 In the event of an emergency where placement continuity is affected, the Engineer will decide if a construction joint will be allowed and will direct the Contractor as to the location and manner in which the joint is to be constructed.

3.7.2.2.6 Concrete shall be cured in compliance with 520.3.10.1. Forms shall not be removed for a period of 3 days or as directed.

3.7.2.3 Extrusion or Slip Form Barrier.

3.7.2.3.1 The extrusion or slipforming equipment shall be self-propelled and shall be capable of placing, consolidating and finishing concrete to the proper line and grade. Extrusion or slip form equipment shall include internal vibrating capability. The Engineer may require the Contractor to demonstrate that the specific equipment proposed for use is capable of satisfactorily placing the concrete mix or furnish evidence of successful operation of the equipment. The Contractor shall furnish the manufacturer's data regarding machine operation to the Engineer.

3.7.2.3.2 The slipforming equipment shall have as nearly a continuous forward movement as possible to provide uniform progress. Stopping and starting of the equipment shall be held to a minimum under sufficient uniform restraint to forward motion in order to produce a well compacted mass of concrete. Concrete shall be supplied and fed into the extrusion or slip form machine at a uniform rate to produce a continuous, completely shaped barrier. Any edge slump resulting from slipforming operations in excess of 1/4 in. (6 mm), as measured from the top surface of the median barrier, exclusive of edge rounding, shall be corrected before the concrete has hardened. If during the operation of the slip-form equipment a tear occurs, it shall be repaired immediately or removed and replaced as directed by the Engineer.

3.7.2.3.3 The grade for the top of the concrete barrier shall be indicated by an offset guide line set by the Contractor. The forming portion of the extrusion or slip form machine shall be readily adjustable vertically during the forward motion of the machine to conform to the predetermined grade line. A grade line gage or pointer shall be attached to the machine in such a manner that a continual comparison can be made between the barrier being placed and the established grade line as indicated by the offset guide line.

3.7.2.3.3.1 Instead of the above method for maintaining the barrier grade, the extrusion or slip form machine may be operated on rails or forms set at uniform depth below the predetermined finished top of the barrier grade, or on existing pavement or bridge decks.

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3.7.2.3.4 Barriers having surface irregularities greater than 3/8 in. (10 mm) in 10 ft (3 m) shall be corrected immediately at the Contractor's expense. Continued variations in the barrier surface exceeding 1/4 in. (6 mm) in 10 ft (3 m) will not be permitted and remedial action shall immediately be taken to correct the problem. Any deformations or bulges remaining after the initial set shall be removed by grinding after the concrete has hardened. The vertical surface at the base of the barrier shall be trowelled true after passage of the slip form machine. All holes and honeycomb shall be patched immediately. The entire surface shall receive a light brush (broomed) finish before final set.

3.7.2.3.5 If concrete placement is terminated for any reason or interrupted for a period of time where the delay will affect the quality and structural integrity of the barrier, the Contractor shall terminate operations by one of the following procedures.

- A. Construct a cast in place expansion joint system as detailed on the standard sheets.
- B. Remove existing unset concrete to a vertical score line with hand tools. The vertical surface resulting from the removed concrete shall remain reasonably rough and unfinished to facilitate interlock and increased bond area when concrete operations are to be resumed. The vertical surface shall be touched up with hand tools to correct unacceptable voids, tears and lack of consolidation resulting from the concrete removal. The surface shall be covered with several layers of wet burlap to prevent drying. All reinforcing steel shall extend beyond the face to provide adequate lapping.

3.7.2.3.6 Concreting operations may resume at the terminated face when the terminated portion has achieved enough rigidity to withstand the sequence of operations it will be subjected to without sustaining damage. All loose or unacceptable concrete and material shall be removed from the terminated face as directed by the Engineer. Immediately prior to placing fresh concrete against a terminated face, the damp surface shall be completely coated with a Bonding Agent appearing on the Qualified Products List. Concrete barrier damaged as a result of the Contractor's operations shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

3.7.2.3.7 The concrete barrier shall be cured in compliance with 520.3.10.1 method "a" or method "b" using a liquid curing compound recommended by the manufacturer of the water repellent (silane-siloxane) used on the barrier and contained on the Department's Qualified Products List. The curing compound, if used, shall be sprayed on the concrete surface immediately following the placing operation at a rate of 1 gallon per square foot (2 liters per 10 square meters). When sawing or forming joints is performed after the application of curing compound, the exposed faces of the barrier in the vicinity of the joint shall be treated with curing compound after sawing or forming the joints.

3.7.2.4 Concrete shall be consolidated as provided in 520.3.5.4 by means of high frequency internal vibrators within 15 minutes after it is placed in the forms. Vibrators shall not be attached to, or held against the forms or the reinforcing steel. Care shall be taken to avoid the displacement of reinforcement.

3.7.2.5 In the event of an emergency where placement continuity is affected, the Engineer will decide if a construction joint will be allowed and will direct the Contractor as to the location and manner in which the joint is to be constructed.

3.7.2.6 Concrete shall be cured in compliance with 520.3.10.1. Forms shall not be removed for a period of 3 days or as directed.

3.7.3 Precast Barriers.

3.7.3.1 Fabrication of precast units shall be performed by an approved commercial precasting plant. The provisions of 105.10 and 106.05 shall apply.

3.7.3.2 Fabrication inspection of the precast barrier will be performed by the Department. A concrete mix design shall be prepared by the manufacturer and approved by the Bureau of Materials and Research prior to fabrication. The Contractor shall notify the Engineer at least 72 hours before casting barriers so that the necessary arrangements may be made for the Engineer to be present for inspection of the casting. The casting date shall be shown on the bottom of each section.

3.7.3.3 The length of individual precast sections shall not exceed 20 ft (6.1 m) unless otherwise permitted. The length of individual sections of any one run shall be approximately the same. Precasting tolerance will allow no variations of more than 1/4 in. (6 mm) in any plan dimension.

3.7.3.4 Unless shown on the plans, the Contractor's proposed method for joining and anchoring the sections shall be submitted for approval. Steel shapes exposed to weathering shall be galvanized.

3.7.3.5 Compaction of the concrete into a dense uniform mass shall be accomplished by internal vibration to provide a smooth surface relatively free of voids. External vibration may be used when permitted.

3.7.3.6 Care shall be taken to ensure that inserts including reinforcing steel remain in their proper locations. Ends of the individual sections shall be smooth and perpendicular to the top surfaces.

3.7.3.7 Curing. Concrete shall be water cured in compliance with 520. Water cured barrier shall not be shipped until the barrier has cured a minimum of 7 days. Steam curing of barriers shall be as follows:

3.7.3.7.1 Furnish sufficient canvas and framework or other type of housing to completely enclose the concrete barrier sections so that the curing temperatures can be controlled.

3.7.3.7.2 Live steam shall be introduced into the enclosure through a series of steam jets which shall be evenly spaced within the enclosure. In no case shall the steam jet impinge directly on the concrete formwork.

3.7.3.7.3 The initial set of the concrete shall take place before steam is applied.

3.7.3.7.4 The steam shall be maintained at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement.

3.7.3.7.5 During the application of the steam, the ambient air temperature shall increase at a rate not to exceed 40 °F (20 °C) per hour until a temperature of 160 °F (70 °C) is reached. Curing at 160 °F (70 °C) shall continue until concrete test cylinders, prepared at the time of placing, and cured under the same temperature and moisture conditions have attained 80 percent of the expected compressive strength.

3.7.3.7.6 Necessary equipment for testing the cylinders shall be available at the fabricator's plant unless otherwise permitted.

3.7.3.7.7 When discontinuing steam, the ambient air temperature shall not decrease at a rate exceeding 40 °F (22 °C) per hour until the temperature has reached 20 °F (10 °C) above the temperature of the air to which the concrete will be exposed.

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3.7.3.7.8 The concrete shall not be exposed to temperatures below freezing for 6 days after casting.

3.7.3.7.9 The precast barrier shall not be moved until 24 hours after casting. The precast sections must be in the position and location for curing prior to removing forms. The lifting hooks shall not be used to move the barrier until curing is complete. Handling shall at all times be performed in a manner to prevent damage to the concrete.

3.7.4 Portable concrete barrier for traffic control. Portable concrete barrier for traffic control may be approved used barrier. Portable concrete barrier for traffic control shall include relocating the barriers on the project as well as transporting the barriers to and from the project.

3.8 Handrail.

3.8.1 Fabricate handrails to the dimensions and details shown on the plans.

3.8.1.1 Top railing shall be continuous throughout entire length of railing, except as noted in 3.8.4.

3.8.1.2 Interconnect handrail members by butt-welding or welding with internal fittings. Welding shall conform to ANSI/AWS D1.1 Chapter 10, Tubular Structures. At tee and cross connections notch ends of intersecting members to fit contour of pipe to which end is joined and weld all around.

3.8.1.3 Form simple and compound curves by bending pipe in jigs to produce uniform curvature. Maintain cylindrical cross-section of pipe throughout entire bend without buckling, twisting, cracking or otherwise deforming exposed surfaces of pipe.

3.8.2 The Contractor shall Install the pipe and hardware for handrail as shown or ordered.

3.8.2.1 Anchor posts in preset sleeves or drilled holes. Sleeves or holes shall be not less than 12 in. (300 mm) deep with an inside diameter not less than 1/2 in. (13 mm) greater than the outside diameter of the post. Sleeves shall have a steel plate closure welded to the bottom and a friction fit, removable cover designed to keep the sleeve clean and hold the 1/2 in. (13 mm) below the finished surface of concrete or mortar rubble masonry.

3.8.2.2 Set handrail accurately in location, alignment and elevation with edges and surfaces level, plumb and true. Fill annular space between posts and sleeve or holes with grout.

3.8.3 Damage to galvanized surfaces during erection shall be repaired by cleaning the damaged area as specified in 550.3.17.2, pretreating as specified in 550.3.17.7 and painting with 2 coats of zinc-rich primer. The second coat shall not be applied until the first coat has been approved.

3.8.4 Provide slip joint expansion joints, at intervals not to exceed 40 feet (12 m), located within 6 in. (150 mm) of posts. Slip joint shall be formed with an internal sleeve extending 2 in. (50 mm) beyond the joint on either side with the sleeve securely fastened to one side.

3.8.5 Handrail shall be installed in a timely manner to ensure pedestrian safety.

3.9 Zinc Inserts shall be installed between rail elements at all lap joint locations where corrosion resistant steel is used. Zinc inserts shall be installed flush with the exposed end of each element.

Method of Measurement

4.1 The accepted quantities of guardrail, new, temporary or reset, will be measured either by the unit or by the linear foot (linear meter) to the nearest 0.1 of a foot (meter), as follows:

4.1.1 Corrugated beam guardrail indicated as “standard section” and Terminal Section Type E-2 will be measured by the linear foot (linear meter) as shown on the plans.

4.1.1.1 Terminal units will each be measured by the unit, except E-2 as noted above

4.1.2 Wood guardrail, pipe guardrail and double faced beam guardrail will be measured from end to end of rail by the linear foot (linear meter). Measurement includes to end of terminal sections unless otherwise shown on the plans.

4.1.3 Handrail will be measured from end to end of rail by the linear foot (linear meter), to the nearest 0.1 of a foot (meter).

4.2 Anchorages shown on the plans as integral parts of terminal units paid for by the unit will not be measured separately; other anchorages as specified, both new and reset, will be measured by the number of units installed.

4.3 Measurement of the temporary beam guardrail and temporary terminal units of the type specified will be in accordance with 4.1.

4.4 The accepted quantities of concrete barrier, permanent or portable for traffic control, will be measured by the linear foot (linear meter) as follows:

4.4.1 Permanent concrete barrier will be measured by the foot (meter) to the nearest 0.1 of a foot (meter) from end to end along the top of the barrier section.

4.4.2 Portable concrete barrier for traffic control will be measured by the linear foot (linear meter) for barrier delivered to the project. Relocating portable concrete barriers on the project will not be measured.

4.5 Delineators will be measured in accordance with 621.4. Delineators required for temporary guardrail and portable concrete barrier for traffic control will not be measured.

4.6 Zinc inserts will not be measured.

4.7 Impact Attenuation devices for traffic control will be measured by the unit. No separate measurement will be made for any materials necessary to connect the impact attenuation device to the concrete barrier or guardrail. No measurement will be made for concrete or base materials required for proper installation. Relocating impact attenuation devices for traffic control on the project will not be measured.

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Basis of Payment

5.1 The accepted quantities per linear foot (linear meter) for guardrail will be paid for at the contract unit price for guardrail complete and in place.

5.1.1 The accepted for quantities terminal units, bridge approach units, anchorages other than anchorages included with terminal units, for all types specified, will be paid for at the contract unit price for units complete and in place.

5.2 New material required for resetting guardrail, other than that damaged due to the Contractor's negligence, will be paid for as provided in 109.04.

5.3 The accepted quantity of permanent concrete barrier of the type specified and portable concrete barrier for traffic control will be paid for at the contract unit price per linear foot (linear meter).

5.3.1 Mortar for patching joints between units on permanent concrete barriers when required will be subsidiary.

5.3.2 Miscellaneous steel for connecting individual units or end units will be subsidiary.

5.3.3 Hot bituminous pavement placed adjacent to the concrete barrier for a maximum width of 1 ft (300 mm) will be paid for under 403.12. Concrete Class A substituted for aggregate base course and hot bituminous pavement will be paid for under 403.12 at 2.0 tons (metric tons) per cubic yard (cubic meter).

5.3.4 Water repellant required on concrete barrier will be subsidiary.

5.4 The accepted quantity of handrail will be paid for at the contract unit price per linear foot (linear meter) complete in place.

5.4.1 Grout will be subsidiary to handrail.

5.5 Delineators will be paid for in accordance with 621.5, except delineators required for temporary guardrail and portable concrete barrier for traffic control will be subsidiary.

5.6 Zinc inserts will be subsidiary to corrosion resistant beam guardrail.

5.7 Impact attenuation devices (redirective or non-redirective), test level 2 or 3 as required will be paid for at the contract unit price per unit complete in place.

5.7.1 All excavation and materials necessary to connect the impact attenuation device to traffic control barrier will be subsidiary.

5.7.2 Any device or device components damaged by the Contractor's negligence shall be replaced at the Contractor's expense.

KEY TO ITEM NUMBERS FOR GUARDRAIL ITEMS

Item Number	Description	Unit
606.00C	Beams for Guardrail	Linear Foot (Linear Meter)
606.01A	Posts for Guardrail	Each
606.1A,B	Steel Beam GR (Galvanized)	Linear Foot (Linear Meter) *
606.1451	Beam Guardrail (Terminal Unit Type MELT)	Unit
606.1452	Beam Guardrail (Terminal Unit Type ELT)	Unit
606.1454	Beam Guardrail (Terminal Unit Type EAGRT 50FT (15.2m))	Unit
606.1455	Beam Guardrail (Terminal Unit Type EAGRT 25FT (7.6m))	Unit
606.147	Beam Guardrail (Terminal Unit Type G-2)	Unit
606.1496	Beam Guardrail (Terminal Section Type E-2)	Linear Foot (Linear Meter)
606.2A,B	Steel Beam GR (Corrosion Resistant)	Linear Foot (Linear Meter) *
606.21A,B	Double-Faced Steel Beam GR (Galvanized)	Linear Foot (Linear Meter)
606.24A,B	Double-Faced Steel Beam GR (Corrosion Resistant)	Linear Foot (Linear Meter)
606.401	Concrete Barrier, Single-Faced	Linear Foot (Linear Meter)
606.402	Concrete Barrier, Double-Faced	Linear Foot (Linear Meter)
606.4029	Modified Concrete Median Barrier	Linear Foot (Linear Meter)
606.411	Concrete Barrier, Single-Faced, Precast	Linear Foot (Linear Meter)
606.412	Concrete Median Barrier, Double-Faced, Precast	Linear Foot (Linear Meter)
606.4129	Modified Concrete Median Barrier, Precast	Linear Foot (Linear Meter)
606.41292	Modified Concrete Median Barrier, Cast-in-Place	Linear Foot (Linear Meter)
606.417	Portable Concrete Barrier(For Traffic Control)	Linear Foot (Linear Meter)
606.421	Concrete Barrier, Single-Faced, Cast-in-Place	Linear Foot (Linear Meter)
606.422	Concrete Barrier, Double-Faced, Cast-in-Place	Linear Foot (Linear Meter)
606.4229	Modified Concrete Median Barrier, Cast-in-Place	Linear Foot (Linear Meter)

*Linear foot (linear meter) except that terminal units are by the unit.

- A Type of Post
- 0 Open
 - 1 Light weight steel (S3x5.7)
 - 2 Medium weight steel (W6x8.5)
 - 3 Open
 - 4 6 inch x 8 inch (150 by 200 mm) wood
 - 5 Round wood 6 inch \pm 1/2 inch (150 \pm 13 mm) at shoulder grade
 - 6 Aluminum, size per plans
 - 7 Heavy weight steel (W6x15.5)
 - 8 Open
 - 9 Aluminum or steel -- Contractor's choice, size per plans
- B Post Spacing or Type of Unit (Spacing of terminal units is standardized on the plans)
- 0 "Standard Section" with 6 foot – 3 inch (1905 mm) spacing
 - 1 Open
 - 2 Open
 - 3 Open

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4	Variable: 25 feet to 6 feet – 3 inches (7620 to 1905 mm) or 3-1/2 feet to 1-1/2 inches (1067 to 38 mm)	
5	Open	
6	Open	
7	Terminal Unit G with 6 foot – 3 inch (1905 mm) spacing	Unit
8	Bridge Approach Unit with 4 foot – 2 inch (1270 mm) spacing	Unit

C	Rail Material
0	Steel (galvanized)
1	Open
2	Open
3	Open
4	Corrosion Resistant Steel
5	Steel Rubbing Rail (galvanized)
6	Steel Top Hand Rail (galvanized)
7	Steel Top Pipe Rail (galvanized)
8	Open

606.5A, B, C Wood Guardrail

Linear Foot (Linear Meter)

Type of Wood Rail	
1	Single 6 inch x 8 inch (150 by 200 mm)
2	Double 6 inch x 8 inch (150 by 200 mm)
5	Double 4 inch x 6 inch (100 by 150 mm)
Type of Posts	
0	5 feet-8 inch x 8 inch (1730 by 200 mm) wood
1	6 feet-6 inch x 8 inch (1980 by 200 mm) wood
2	5 feet- 9 inch (1750 mm) by W6x8.5 steel
3	5 feet-9 inch (1750 mm) by W6x15.5 steel
4	1 foot –5 inch (430 mm) by W6x15.5 steel
5	2 feet-5-1/4 inch (740 mm) by W6x15.5 steel

C	Post Spacing
7	7 feet-6 inch (2290 mm)
8	8 feet-0 inch (2440 mm)

606.6A, B, C Handrail

Linear Foot (Linear Meter)

A	Type
1	Step
2	Ramp
3	Safety Rail
B	Guard Required
0	No Guard
1	With Guard
C	Material
1	Steel

606.82	Anchorage for Beam Guardrail	Each
606.83	Anchorage for Strong Beam Guardrail	Each

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606.91	Resetting or Setting Guardrail	Linear Foot (Linear Meter)
606.92	Resetting Anchorages	Each
606.93	Temporary Beam Guardrail	Linear Foot (Linear Meter)
606.9512	Temporary Impact Attenuation Device (redirective), Test Level 2	Unit
606.9513	Temporary Impact Attenuation Device (redirective), Test Level 3	Unit
606.9522	Temporary Impact Attenuation Device (non- redirective), Test Level 2	Unit
606.9523	Temporary Impact Attenuation Device (non- redirective), Test Level 3	Unit

SECTION 607 -- FENCES

Description

1.1 This work shall consist of the constructing, removing and resetting railings, fences, and gates as shown on the plans or as ordered. This work shall include furnishing and installing the required electrical grounds.

Materials

2.1 Woven Wire Fence.

2.1.1 Wire shall conform to ASTM A 116, Design No. 1047-12-11. Minimum coating shall meet Class 1.

2.1.2 Steel posts and angle braces shall conform to ASTM A 499 and A 702. Posts shall be galvanized in accordance with AASHTO M 111. Fittings, hardware and other appurtenances not specifically covered by the plans and specifications shall be standard commercial grade, manufactured in accordance with current standard practice.

2.1.3 Tie wires and wire clips shall be of equivalent size and coating as specified in 2.1.1.

2.1.4 Gates. Gate posts shall conform to 2.1.2. Wire shall conform to 2.1.1. The frame, center brace, diagonal tension rod, and hardware shall conform to the standards shown on the plans.

2.2 Chain Link Fence.

2.2.1 Chain link fence shall conform to AASHTO M 181.

2.2.2 Unless otherwise stipulated, fencing material shall be 9 gauge, 2 inch (3.76 mm, 50 mm) mesh, Type II or Type IV fabric. The specific diameter for Type IV fabric is the metallic coated diameter and the PVC coating shall not be used when determining wire size. All vinyl-coated fabric used on the project shall be the same shade of green.

2.2.2.1 Fabric up to and including 60 inch (1.5 m) high shall be knuckled at the top and bottom selvages. Fabric over 60 inch (1.5 m) high shall be twisted and barbed on the bottom selva and knuckled on the top selva.

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2.2.3 Metallic coated steel posts, rails, or gate frames shall conform to AASHTO M 181 Grade 1 or Grade 2. Miscellaneous fittings and hardware shall conform to AASHTO M 181 Section 29.

2.2.4 Tension bars shall not be less than 0.25 by 0.75 inch (6 by 19 mm).

2.2.5 Wire ties and clips for fastening fabric to posts and top rail shall be of the same material and the same or larger gauge as the fabric.

2.3 Barbed wire. Barbed wire, unless otherwise specified, shall be fabricated from 2 ply 12-1/2 gauge (2.51 mm), Class 3 zinc-coated steel wire, with 14 gauge (2.03 mm) 4-point barbs spaced not more than 5 inch (130 mm) apart, and shall meet the requirements of ASTM A 121.

2.4 Additional materials required for resetting railings or fencing or both shall conform in quality and type to the materials in the existing fence.

2.5 Concrete shall conform to 520.

2.6 Protective coating for contact surfaces of aluminum and concrete shall be either an approved zinc-rich primer, or an approved bituminous paint meeting FSS TT-C-494.

Construction Requirements

3.1 General.

3.1.1 The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to the required grade and alignment.

3.1.2 At locations where breaks in a run of fencing are required, or at intersections with existing fences, appropriate adjustment in post spacing shall be made.

3.1.3 The fence shall be permanently connected to the existing fence.

3.1.4 Posts, braces, or anchors shall be embedded in concrete and temporary guys or braces may be required to hold the posts in proper position until such time as the concrete has set sufficiently to hold the posts. Unless otherwise permitted, no materials shall be installed on posts or strain placed on guys and bracing set in concrete until 3 days have elapsed from the time of placing of the concrete.

3.1.4.1 The portions of aluminum posts which will be in contact with concrete shall be coated both inside and outside with protective coating to 1 inch (25 mm) above the top of the concrete. The coating shall be allowed to dry for at least 24 hours before the concrete is placed.

3.1.4.2 In wet areas, when it is impractical to place concrete, steel drive anchor assemblies may be required.

3.1.5 All posts shall be set plumb and firm and to the required grade, spacing, and alignment. Cutting of the posts will be allowed only with the approval of the Engineer.

3.1.6 When it is necessary to drill into rock to set a steel post, the post may be shortened, provided a minimum length of 12 inch (300 mm) of post is grouted in the rock.

3.1.7 At each location where an electric transmission, distribution, or secondary line crosses any of the types of metal fences covered by these specifications, the fence shall be grounded as required by the electric utility company.

3.1.7.1 At locations where electric lines run parallel and in close proximity to metal fences, grounding systems may be required by the electric utility company.

3.1.8 Where it is impractical to conform the fence to the general contour of the ground, as at ditches, the opening beneath the fence shall be closed as ordered.

3.1.9 All surplus material and other debris shall be removed.

3.2 Woven Wire Fence.

3.2.1 The wire shall be stretched so that not more than 1/2 of the hump is removed from the horizontal wire. The top and bottom wire and alternate parallel interior wires shall be fastened at every post in such a manner that each interior wire shall have a fastening at every other post.

3.2.1.1 Runs of woven wire fence 600 ft (180 m) or less in length shall be erected with not more than one splice between post assemblies. Except as otherwise provided, splicing the wire will be permitted at posts only. Each horizontal strand of wire shall be wrapped completely around posts at post assemblies and shall be securely fastened by winding the end of the wire about the same strand where it leads up to the post. Other devices designed specifically to splice fencing wire may be used when approved. Post assemblies shall be constructed at all corners, ends, gates, at extreme sags or humps in grade, and at ends of 600 ft (180 m) lengths of fencing.

3.3 Chain Link Fence.

3.3.1 The fence shall be erected so that the bottom is between 1 and 2 inch (25 and 50 mm) above the ground.

3.3.1.1 The top rail shall pass through the post tops to form a continuous brace from end to end of each section of fence, and shall be securely fastened to the posts at post assemblies by suitable clamps.

3.3.1.2 Post assemblies as shown on the plans shall be installed at ends, at corners or changes in line where the angle of deflection is 30 degrees or more, at abrupt changes in vertical grades where pull posts are required, and at gates. Moreover, at least one post assembly shall be installed for every 500 ft (150 m) of run.

3.3.1.3 Braces shall be spaced approximately midway between the top and the ground, and extend to the first line post. Braces shall be securely fastened to posts by suitable clamps.

3.3.1.4 Truss rods shall be installed as shown on the plans.

3.3.2 Unless otherwise shown on the plans, when barbed wire is required, arms shall be installed outward.

3.3.3 Fabric shall be fastened to the post with suitable fabric bands, stretcher bar bands, and hook bolts and to the top rail with tie wires as shown on the plans. The fabric shall be free from sags and bends.

3.3.4 All holes within 2 ft (600 mm) of the fence shall be filled with suitable approved material and compacted properly.

3.4 Temporary fence. Fences holding livestock shall be promptly replaced by temporary fencing, with no extra compensation, during the time between the removal of the old fence and the erection of the

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new fence. Fencing meeting the specifications for the project may be used in its permanent location after having been used as temporary fence, provided the fencing has not been damaged.

3.5 Gates. Gates shall be firmly and securely erected in accordance with the recommendations of the manufacturer and as directed.

3.6 Resetting. The existing railing or fencing shall be carefully removed, transported and reset at the required location. The reset railing or fencing shall be at least equivalent in strength and appearance to the original railing or fencing. Additional materials such as fittings or hardware shall be furnished and installed as necessary.

3.7 Barbed wire. The installation of barbed wire along the right-of-way is not allowed (see RSA 236:15).

Method of Measurement

4.1 All fence, new or reset, will be measured by the linear foot (linear meter), to the nearest 0.1 of a foot (meter). Measurement will be along the top of the fence for each continuous run.

4.1.1 Woven wire fence and chain link fence will be measured from center to center of end posts or gate posts as the case may be.

4.1.2 Railing reset will be measured from end to end of rail.

4.2 Post assemblies of the kind specified will be measured by the number of units. A unit shall consist of the post and all its required hardware and anchorages.

4.3 Gates will be measured as complete units of the size and type specified.

Basis of Payment

5.1 The accepted quantities of fencing of the type specified and of the height required will be paid for at the contract unit price per linear foot (linear meter), complete in place. This unit price shall include the cost of furnishing all labor, tools and equipment to satisfactorily complete the work and shall include excavation, concrete or steel drive anchor assemblies, posts, hardware, fencing and any repair of material damaged by the Contractor's operation. Gates and post assemblies, complete in place, shall be paid for as units. Clearing necessary to provide space for erecting the fencing will be paid for as provided under Item 201.6.

5.2 The accepted quantity of railing or fencing reset will be paid for at the contract unit price per linear foot (linear meter) complete in place, except that the cost of furnishing additional materials, including new post concrete embedment, required through no fault of the Contractor will be paid for as Extra Work. Removing old concrete embedment from the posts will be subsidiary to the resetting item.

Pay items and units (ENGLISH):

607.1	Woven Wire Fence	Linear Foot
607.13	Woven Wire Fence with Wood Posts	Linear Foot
607.20 _	_ft Woven Wire Gates	Each
607.41	Post Assemblies for Woven Wire Fence	Each
607.6 _2	Chain Link Fence with Aluminum Coated Steel Fabric, _ft High	Linear Foot

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607.6 _5	Chain Link Fence with Vinyl-Coated Steel Fabric, _ft High	Linear Foot
607.6 _9	Post Assemblies for Chain Link Fence, _ft High	Each
607.7 _2	_ft Chain Link Gates with Aluminum Coated Steel Fabric, _ft High	Each
607.7 _5	_ft Chain Link Gates with Vinyl Coated Steel Fabric, _ft High	Each
607.8 _2	_ft Opening Chain Link Double Gates with Aluminum Coated Steel Fabric, _ft High	Each
607.8 _5	_ft Opening Chain Link Double Gates with Aluminum Coated Steel Fabric, _ft High	Each
607.9	Resetting Railing and Fencing	Linear Foot

Pay items and units (METRIC):

607.1BC	Woven Wire Fence <u>B.C</u> m High	Linear Meter
607.1BCDE	Woven Wire Fence <u>B.C</u> m High, <u>D.E</u> m Wide	Linear Meter
607.1BC9	Post Assemblies for Woven Wire Fence <u>B.C</u> m High	Linear Meter
607 .A BC DE .A	Item Number Type of Fence 2 = Chain Link Fence with Aluminum Coated Steel Fabric 3 = Chain Link Fence with Vinyl Coated Steel Fabric 4 = Post Assemblies for Chain link Fence 5 = Chain Link Double Gate Opening with Aluminum Coated Steel Fabric 6 = Chain Link Double Gate Opening with Vinyl Coated Steel Fabric 7 = Wood Fence 8 = Miscellaneous Fence Types (Iron, Barbed Wire, etc.)	
BC DE	Height of Fence, B.C m Width of Gate (if necessary), D.E m	
607.7 BC D BC D	Item Number Height of Fence, B.C m Type of Wood Fencing 2 = Vertical Board 4 = Stockade Screen 6 = Woven Stockade	
607.9	Resetting Railing and Fencing	

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SECTION 608 -- SIDEWALKS

Description

1.1 This work shall consist of constructing sidewalks of either hot bituminous pavement, or Portland cement concrete, reinforced when specified. Portland cement concrete sidewalks shall receive a protective coating unless otherwise directed.

Materials

2.1 Base course materials shall conform to 209.2.1.2.

2.2 Portland cement concrete shall be Class A conforming to 520.

2.2.1 Coarse aggregate shall be standard size #67.

2.2.2 Protective coating shall be Silane-Siloxane conforming to 534.2.2.

2.3 Reinforcement shall conform to 544.2.

2.4 Joint filler shall conform to AASHTO M 213.

2.5 Hot bituminous pavement shall meet the material requirements of 401 except that the composition of mixtures shall conform to the limits of Table 1.

Table 1 - Composition of Mixtures - Master Ranges English (Metric)

Sieve Size	Binder Course	Wearing Course
	Percentage by Weight Passing	
1/2 in (12.5 mm)	95 – 100	---
3/8 in (9.5 mm)	90 – 100	98 - 100
No. 4 (4.75 mm)	45 – 75	80 - 100
No. 10 (2.00 mm)	30 – 50	40 - 65
No. 20 (0.850 mm)	17 – 37	25 - 45
No. 40 (0.425 mm)	10 – 30	18 - 33
No. 80 (0.180 mm)	5 – 20	8 - 20
No. 200 (0.075 mm)	2 – 6	2 - 6
Asphalt Cement	5.5 - 7.5	6 - 9
Percent of Mixture		

Construction Requirements

3.1 Bituminous Sidewalks.

3.1.1 Subgrade and base course. The subgrade shall be carefully graded and compacted. The base course material shall be spread and rolled to a smooth surface and to the required cross-section.

3.1.2 General. The plant, mixing methods, and hauling shall conform to the provisions of 401.

3.1.2.1 The compacted binder course shall be 1 in (25 mm) less in thickness than the total thickness of the sidewalks.

3.1.2.2 The compacted wearing course shall be 1 in (25 mm) in thickness.

3.1.3 Placing. The bituminous pavement shall be spread uniformly in two courses as specified above. Each course shall be rolled with a roller weighing between 500 lb (230 kg) and 2,000 lb (900 kg). The finished surface shall be uniform in appearance, free from irregularities, and shall present a smooth surface. The edges shall be trimmed as directed.

3.1.4 Backfilling. The edges of the sidewalk shall immediately be backfilled as necessary with suitable material compacted and finished flush with the top of the sidewalk.

3.2 Concrete Sidewalks.

3.2.1 Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm, even surface conforming to the section shown on the plans. All soft and yielding material shall be removed and replaced with acceptable material.

3.2.2 Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

3.2.3 The foundation and granite curb shall be thoroughly moistened immediately prior to the placing of the concrete. Any standing water shall be removed before the concrete is placed. The proportioning, mixing, and placing of the concrete shall be in accordance with 520.3.

3.2.4 Reinforcement in reinforced concrete sidewalk shall be placed at mid-depth or as shown on the plans, using the methods described in 544.3.

3.2.5 Finishing.

3.2.5.1 Concrete shall be finished by use of wood, or magnesium floats, by skilled concrete finishers. A fine-grained broom finish shall be applied to all concrete sidewalks subject to foot traffic.

3.2.5.2 All outside edges and expansion or construction joints shall be edged with an edging tool having a radius of 1/4 in (6 mm). All crack control joints in sidewalks subject to foot traffic shall be edged with a jointing tool.

3.2.6 Joints.

3.2.6.1 Construct transverse and longitudinal crack control joints by sawing, jointing tool or other approved method to a minimum depth of one third the slab thickness. If the jointing tool is not capable of constructing a joint to the correct depth, saw the joint to the correct depth. Saw crack control joints as soon as concrete has hardened sufficiently to permit sawing without excessive raveling and before uncontrolled shrinkage cracking occurs, usually between four and twenty four hours. Control joints for cracking shall be spaced at 8 ft [2.5 m] and 12 ft [3.5 m] for slab thickness of 4 in [100 mm] and 6 in [150 mm] respectively, unless otherwise specified. Form crack control joints every 5ft (1.5 m) in sidewalks subject to foot traffic. Bond breaker shall be used at all construction joints.

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3.2.6.2 Expansion joints shall be formed at any angles or intersections in the sidewalks, around all appurtenances such as manholes, utility poles and catch basins, and between buildings or bridges. Preformed expansion joint filler of the thickness indicated shall be installed for the full depth of the slab.

3.2.7 Curing. Concrete shall be cured for a minimum of 7 days. Curing compounds will not be permitted. Plastic sheets or other approved materials shall be placed in close contact with the finished concrete as soon as the concrete has set sufficiently to avoid damage from the placement of coverings. The protective covering shall be maintained vapor-proof in close contact with the concrete for the entire 7 day period. All traffic shall be excluded during the curing period. Vehicular traffic shall be excluded for such additional time as ordered.

3.2.8 Protective coating. Protective coating shall be applied in accordance with 534.3.

Method of Measurement

4.1 Sidewalks will not be measured, but shall be the square yard (square meter) final pay quantities in accordance with 109.11 for sidewalks required as shown on the plans. The area occupied by the curb will not be included in the final pay quantity.

4.1.1 Protective coating will not be measured.

4.2 Base course material will be measured by the cubic yard (cubic meter) determined by the product of the area of sidewalk approved for payment and the depth shown on the plans or ordered.

Basis of Payment

5.1 Sidewalks are final pay quantity items and will be paid for at the contract unit price per square yard (square meter) complete in place in accordance with 109.11.

5.1.1 Protective coating for concrete sidewalks will be subsidiary.

5.2 Base course material will be paid for as shown on the plans.

5.3 Necessary excavation will be paid for under 203.

Pay items and units (ENGLISH):

608.1_	_in Bituminous Sidewalk (F)	Square Yard
608.2_	_in Concrete Sidewalk (F)	Square Yard
608.3_	_in Reinforced Concrete Sidewalk (F)	Square Yard

Pay items and units (METRIC):

608.1_	_mm Bituminous Sidewalk (F)	Square Meter
608.2_	_mm Concrete Sidewalk (F)	Square Meter
608.3_	_mm Reinforced Concrete Sidewalk (F)	Square Meter

SECTION 609 -- CURBS**Description**

1.1 This work shall consist of constructing or resetting curbs as shown on the plans or as ordered.

Materials

2.1 Curb shall be new granite, salvaged granite, or bituminous, as indicated in the proposal.

2.2 Granite shall be hard, durable, reasonably uniform in appearance, and free from weak seams. Solid quartz or feldspar veins will not be cause for rejection.

2.2.1 Surfaces of each stone shall be finished in accordance with the requirements of Table 1. All comparable curbs on the project shall have similar finishes.

2.2.2 When the slope curb item description does not indicate a specific height, the size of the stone shall be as shown on the standard entitled "Granite Slope Curb". The setting reveal (the vertical height of the exposed face when set) shall be 4 in (100 mm) or as shown on the plans.

2.3 Salvaged granite curbing shall be dressed to obtain joints of the same width as specified for new curb.

**TABLE 1
FINISHED SURFACES AND TOLERANCES,
FOR GRANITE CURBING**

TYPE	AREA	FINISHED SURFACE	TOLERANCE, INCHES^a (MILLIMETERS)	
STRAIGHT OR CURVED	Top	5 in (125 mm) wide or as otherwise shown, sawn true plane.	+1/8 (+3)	-1/8 (-3)
		Front and back arris lines pitched straight and parallel.	+1/8 (+3)	-1/8 (-3)
	Front face	Right angle to top, approximately true plane. No drill holes showing in top 10 in (250 mm).	+1 (+25)	-1/2 (-13)
	Back face: Exposed	Plane parallel with front face. Straight split to 1-1/2 (40 mm) below exposed surface. No larger than 1/4 in (6 mm) segment of drill holes showing in arris lines.	+1 (+25)	-1 (-25)
	Concealed	Below 1-1/2 in (40 mm) from	+1-1/2 (+40)	-1-1/2 (-40)

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		exposed surface.		
	Bottom	Approximately parallel to top. Minimum width: 3 in (75 mm).	See plans.	
	Ends:			
	Exposed portion	Square with planes of top and face.		
	Joints:			
	Exposed	Optimum width: 1 in (25 mm).		
	Concealed	To break back no more than 4 in (100 mm).	+3/4 (+20)	-3/4 (-20)
TYPE	AREA	FINISHED SURFACE	TOLERANCE, INCHES (MILLIMETERS)	
	Lengths of stones	3 to 10 ft (1 to 3 m) with 50 percent of sections to be 5 ft (1.5m) or greater, or as indicated.		
BRIDGE		Conform to Straight Curb except as specified below.		
	Exposed surfaces	No drill holes showing; none in back face arris lines.		
	Bottom	Width equal to width of top.	+1/2 (+12)	-1/2 (-12)
	Joints:			
	Exposed	Maximum width: 1/2 in (13 mm).	+1/4 (+5)	
	Concealed	Split face to break back no more than 1 in (25 mm).		
SLOPE AND END STONE	Arris lines	Straight and true on top, front and ends. Drill holes not deeper than 1/4 in (6 mm) allowed in arris lines.	+1/4 (+5)	-1/4 (-5)
	Faces:			
	Exposed part	Planes; no drill holes in faces longer than 8 in (200 mm) or deeper than 1/4 in (6 mm).	+1 (+25)	-1 (-25)
	Concealed part	Drill holes not objectionable.		
	Ends	Square with face except as		

indicated.

TYPE	AREA	FINISHED SURFACE	TOLERANCE, INCHES (MILLIMETERS)	
	Joints	On tangent, maximum width: 1 in (25 mm). On curves over 15 ft (4.5 m) radius, widen top or bottom from 1 in (25 mm) as necessary.	+1/2 (+13)	-1/2 (-13)
		On curves with 4.5 m (15 ft) radius and under, use radial joints or curved curb as indicated. Optimum width: inch (25 mm)	+1/2 (+13)	-1/2 (-13)
	Length of stones	Min. and max. specified lengths.	See plans.	
^a + Projection in stone; -Depression in stone				

2.4 Bituminous curb shall meet the requirements of 401 except that the composition of the mixture shall conform to the limits of Table 2. The mixture shall extrude properly with a uniform, smooth appearance.

Table 2 Required Grading For Bituminous Curb

SIEVE SIZE	PERCENTAGE BY WEIGHT PASSING
3/4 inch (19.0 mm)	100
1/2 inch (12.5 mm)	86.0 - 100
3/8 inch (9.5 mm)	75.0 - 100
No. 4 (4.75 mm)	60.0 - 80.0
No. 8 (2.36mm)	42.0 - 62.0
No. 16 (1.18 mm)	30.0 - 49.0
No. 30 (0.600 mm)	22.0 - 39.0
No. 50 (0.300 mm)	14.0 - 27.0
No. 200 (0.075 mm)	3.0 - 10.0
Asphalt Cement, percent of Mix	7.0 - 9.0

2.4.1 Polyester fibers, as included on the Qualified Products List, shall be uniformly incorporated in the dry mix in the proportion of approximately 1/4 percent of the total batch weight.

2.4.2 Curb paint shall be Ready-Mixed White or Yellow Traffic Paint in conformance with either 708-NH 4.11 or 708-NH 4.12, respectively.

2.4.3 Beads for reflectorization shall conform to 708.

2.5 Cement mortar shall conform to 707 except that cement mortar for bedding curb (bridge) shall be an approved non-shrink, non-metallic grout mixed as recommended by the manufacturer. The non-shrink, non-metallic grout shall be a product as included on the Qualified Products List. When the

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bedding is more than 3/4 in (19 mm) in height, a 3/8 in (9.5 mm) washed stone may be mixed into the mortar at the maximum of 1 part stone to 4 parts dry mortar.

2.6 Curb anchors shall be zinc-coated (galvanized) steel in accordance with ASTM A 653/A 653M, coating designation G 90 of shapes and dimensions as shown on the plans.

2.7 Backfill material shall conform to the appropriate material shown on the plans.

Construction Requirements

3.1 Granite Curb, New and Reset.

3.1.1 Excavation for curb shall be made to the required depth, and the base upon which the curb is to be set shall be compacted to a firm even surface.

3.1.2 Installation of curbing shall be so that the front top arris line conforms to the line and grade required. All spaces under the curbing shall be filled with material conforming to the requirements for roadway base course. This material shall be thoroughly tamped.

3.1.3 Joints shall be of the width indicated in Table 1. They shall be pointed with mortar and the exposed portions finished with a jointer.

3.1.4 Curbing to be salvaged and reset shall be carefully removed and stored. The Contractor shall replace any curbing damaged or lost because of his negligence. All exposed portions of reset curbing shall be cleaned by sand blasting.

3.1.5 Backfilling shall be accomplished immediately after the curb is set and jointed. Backfill shall be of approved material, placed and thoroughly tamped.

3.1.5.1 Concrete Class B in accordance with 520 may be substituted for aggregate base course and hot bituminous base courses in the curb patch on the roadway side of granite curb. Concrete thickness shall be not less than that of the adjacent pavement.

3.1.6 Bridge curb shall be set on a mortar bed of non-shrink, non-metallic grout. The front face shall be plumb and the top shall conform to the required line and grade. All joints shall be grouted and the exposed portions finished with a jointer. Long and short lengths of curb shall be laid alternately unless otherwise ordered.

3.1.6.1 Curb anchors shall be set and grouted as shown on the plans.

3.2 Bituminous Curb.

3.2.1 Prior to placing the curbing, the surface of the pavement shall be cleaned as directed and painted with a tack coat of bituminous material when ordered.

3.2.2 The curbing shall be placed by means of an approved extruding curb paver. The curbing shall be compacted to a minimum density of 90 percent of a laboratory compacted sample of the same mix. A tight bond shall be obtained between the prepared course and the curb and between necessary curb joints.

3.2.3 When painted curb is specified, the exposed surfaces of the curbing shall be painted with two coats of curb paint in accordance with the paint manufacturer's recommendations after a curb curing period that shall be as long as project conditions permit, but no sooner than seven days. Primer and finish

coats shall be applied at a rate to obtain a wet thickness of 16 mils (400 µm) each application. The finish coat is intended to serve as the vehicle for holding the beads for reflectorization.

3.2.4 The beads for reflectorization shall be applied by the drop-on method at the time of application of the second coat of paint, evenly and uniformly, at the rate to obtain the adhesion of the maximum number of beads possible. Dead spots found upon testing after dark shall be repainted and additional beads applied.

Method of Measurement

4.1 Curb will be measured by the linear foot (linear meter) to the nearest 0.1 of a foot (meter) from end to end along the lower edge of the exposed face of the curbing. Only curbing actually cut to a radius will be considered as curved curb. Slope curb shown or ordered to be cut on radial joints, (not square with face) will be measured separately.

Basis of Payment

5.1 The accepted quantities of curb will be paid for at the unit price per linear foot (linear meter) for each type of curbing specified, complete in place, except that all special cutting ordered due to changes in the plans will be paid for as provided in 109.04.

5.2 Roadway base course material adjacent to the curb will be paid for under the appropriate items and no deduction will be made for the volume occupied by the curb. In the process of setting the curb, excavation and backfill of the material that has been placed by the Contractor will be considered as incidental to the item.

5.3 Hot bituminous base courses placed adjacent to the curb for a maximum width of 1 ft (300 mm) will be paid for under 403.12. Concrete Class B substituted for aggregate base course and hot bituminous base courses will be paid for under 403.12 at 2.0 tons (metric tons) per cubic yard (cubic meter).

Pay items and units (ENGLISH):

609.01	Straight Granite Curb	Linear Foot
609.02	Curved Granite Curb	Linear Foot
609.21	Straight Granite Slope Curb	Linear Foot
609.21_	Straight Granite Slope Curb _inch High	Linear Foot
609.22	Straight Granite Slope Curb with Radial Joints	Linear Foot
609.22_	Straight Granite Slope Curb with Radial Joints _in High	Linear Foot
609.23	Curved Granite Slope Curb	Linear Foot
609.23_	Curved Granite Slope Curb _inch High	Linear Foot
609.3	Straight Granite Curb (Bridge)	Linear Foot
609.311	Straight Granite Curb (Bridge), Modified	Linear Foot
609.35	Curved Granite Curb (Bridge)	Linear Foot
609.5	Reset Granite Curb	Linear Foot
609.51	Setting Granite Curb Furnished by Others	Linear Foot
609.55	Reset Granite Curb (Bridge)	Linear Foot
609.811	Bituminous Curb, Type B (4 inch Reveal)	Linear Foot
609.812	Bituminous Curb, Type A	Linear Foot

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Pay items and units (METRIC):

Height to the nearest 10 mm

609.01	Straight Granite Curb	Linear Meter
609.02	Curved Granite Curb	Linear Meter
609.21	Straight Granite Slope Curb	Linear Meter
609.21__	Straight Granite Slope Curb __mm High	Linear Meter
609.22	Straight Granite Slope Curb with Radial Joints	Linear Meter
609.22__	Straight Granite Slope Curb with Radial Joints __mm High	Linear Meter
609.23	Curved Granite Slope Curb	Linear Meter
609.23__	Curved Granite Slope Curb __mm High	Linear Meter
609.3	Straight Granite Curb (Bridge)	Linear Meter
609.311	Straight Granite Curb (Bridge), Modified	Linear Meter
609.35	Curved Granite Curb (Bridge)	Linear Meter
609.5	Reset Granite Curb	Linear Meter
609.51	Setting Granite Curb Furnished by Others	Linear Meter
609.55	Reset Granite Curb (Bridge)	Linear Meter
609.811	Bituminous Curb, Type B (100 mm Reveal)	Linear Meter
609.812	Bituminous Curb, Type A	Linear Meter

SECTION 614 -- ELECTRICAL CONDUIT

Description

1.1 This work shall consist of furnishing, installing and testing conduit of the size and type specified, including sweeps, bends, joints, hangers, pull boxes, special fittings, plastic warning tape and other appurtenances, as shown on the plans or ordered. Common structure excavation to the depth specified in 206.4.1, bedding if required, and backfill shall be included in this work. This work shall also include the disposal of discarded materials and the restoration of disturbed surfaces when not otherwise included under other items in the contract.

Materials

2.1 Steel conduit and steel conduit for sleeves shall conform to ASTM A 53 Standard Weight and shall be galvanized unless otherwise specified.

2.2 Electrical plastic tubing (EPT) and electrical plastic conduit (EPC) including fittings and joint requirements shall conform to NEMA TC 2 and shall be made from polyvinyl-chloride (PVC). Conduit shall be marked in accordance with NEMA TC 2-6.1.

2.3 Concrete for cast in place conduit encasement shall conform to 520, Class B. Precast concrete encased conduit will not be permitted.

2.4 Plastic warning tape shall be American Public Works Association standard 6 inch (150 mm) wide polyethylene color coded and marked in accordance with the utility industry standards for marking underground utility lines.

2.5 Concrete pull boxes, either precast or cast in place, shall be constructed using concrete conforming to 520, Class A and designed for AASHTO H20 loading. Frame and cover castings shall be gray iron conforming to AASHTO M 105. Unless otherwise specified, all gray iron castings shall be Class 30. Covers shall be secured to the frame with two stainless steel hex head bolts conforming to ASTM A 240 Type 304. Pull boxes and covers shall be constructed as detailed on the plans.

2.6 Molded pull boxes shall be either fiberglass-filled high density polyethylene (HDPE), fiber reinforced polyester mortar, or fiberglass cloth reinforced polymer concrete, all with high impact resistance, ultraviolet stabilization tested per ASTM G53 and Chemical resistant tested per ASTM 543 section 7. The box and cover shall be designed for off roadway applications subject to incidental, non-deliberate heavy vehicular traffic in accordance with the Western Underground Committee Guide 3.6 for non-concrete enclosures (WUC Guide 3.6). Boxes and covers shall be tested with the cover in place.

2.6.1 The cover shall withstand a vertical test load of 20,800 lb (86 kN) applied at the center of the cover, by a 10" x 10" (250 by 250 mm) plate, with less than ½" (12.5 mm) deflection over 10 test cycles. The boxes shall withstand a vertical box wall test load of 20,800 lb (86 kN) applied by a 10" x 10" (250 by 250 mm) plate with a 5" x 10" (125 by 250 mm) area centered on the long wall with no more than ¼" (6 mm) deflection per foot (0.3 m) of length of enclosure over 10 test cycles. Boxes shall also withstand a lateral sidewall test load of 1,200 lb per square foot (22 kN) applied by a plate 24" (600 mm) by the depth of the box, with no more than ¼" (6 mm) deflection per foot (0.3 m) of length of enclosure over 10 test cycles. Tested in accordance with Section 4.1 of WUC Guide 3.6. Permanent deflection of any surface shall not exceed 10 percent of the maximum allowable static test load deflection.

2.6.2 Enclosures shall be designed and suitable for installation and use through a temperature range -40° F to 195° F (-40° C to 90° C)

2.6.3 Covers, boxes and extensions shall meet the acceptance criteria in accordance with Section 5.3 of WUC Guide 3.6. A spray or paint covering shall not be used to achieve the required nonflammability.

2.6.4 Boxes and extensions shall have adequate soil bearing surface to prevent settling in any soil, when tested in accordance with Section 4.1 of WUC Guide 3.6.

2.6.5 Covers and extensions shall be interchangeable with other boxes of the same material type and size manufactured to WUC Guide 3.6.

2.6.6 Any point on the covers shall withstand a 70 lb(f)-ft (95 N-m) impact administered with a 12 lb (5.4 kg) weight using a "C" TUP (ASTM D-2444) without puncturing or splitting. The test shall be performed with the cover resting upon a flat, rigid surface such as concrete or a 1" (25 mm) steel plate.

2.6.7 Cover surface shall provide a minimum coefficient of friction of 0.50. Covers shall be secured to box with two hex-head stainless steel bolts conforming to ASTM A 240 Type 304. Bolts shall be self-retaining and shall withstand a minimum of 70 lb(f)-ft (95 N-m) torque and have a minimum of 750 lbs (3.3kN) straight pull out strength. Nuts shall be floating, replaceable and in a nut cavity which is free draining and shall provide a minimum of ½" (12.5 mm) movement from the center of the nut.

2.6.8 A Certificate of Compliance that the enclosure meets the above requirements when tested in accordance the Western Underground Committee Guide 3.6 testing procedures by a nationally recognized independent testing laboratory shall be provided.

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Construction Requirements

3.1 General.

3.1.1 Installations within the limits of the traveled way and shoulders, whether paved or unpaved, shall be constructed with Schedule 80 PVC conduit (EPC), rigid steel conduit, or concrete encased Schedule 40 PVC conduit (EPC).

3.1.2 Installations beyond the limits of the traveled way and shoulders shall be constructed with Schedule 80 PVC conduit (EPC), Schedule 40 PVC conduit (EPC), or rigid steel conduit. These materials may also be used under sidewalks and parking lots subject to incidental heavy vehicular activity.

3.2 Bedding. When conduit is installed within traveled ways, shoulders, sidewalks and parking areas, the backfill shall be placed to 6 in (150 mm) above the conduit or encasement and compacted by pneumatic tampers, vibratory compactors, or other approved means. Additional backfill shall be placed in layers not greater than 6 in (150 mm).

3.3 Laying.

3.3.1 Conduit shall be laid to a pitch of not less than 3 inches per 100 feet (75 mm per 30 m).

3.3.2 All conduit lines located under pavement shall be installed in a straight line. Field bends required in other areas shall be made with an approved conduit bender. Not more than four 90 degree bends or equivalent (360 degree total) shall be used on a continuous conduit line. Bending radius shall not be less than 30 ft (9 m) unless otherwise directed. Bends in conduit entering pull boxes, light pole bases, signal and meter pedestal bases, transformer pads, signal controller bases and at risers shall be made with manufactured electrical standard elbows.

3.3.3 All conduit connections shall be waterproof and conform to NEMA TC 2-3.4. When conduit of one material is to be joined to an existing conduit of another material, weatherproof adapters manufactured for the purpose shall be used. Waterproofing and sealing compounds containing bituminous material shall not be used.

3.3.4 When conduits are encased in concrete, concrete cover around ducts shall be a minimum of 3 inch (75 mm) with a minimum separation of 1 1/2 inch (38 mm) between ducts unless otherwise specified or ordered. After the initial set, the concrete shall be protected from the air and sun. Fill shall not be placed over the conduit until authorized by the Engineer.

3.3.5 Conduit risers installed on poles or other structures shall extend a minimum of 10 ft (3 m) above the elbow and be of a type and total height to meet utility company requirements. Conduits shall be attached with an approved support strap. A suitable plug shall be installed in the end of the conduit riser.

3.3.6 When ordered, conduit shall be placed under existing pavement by approved jacking or drilling methods which do not disturb the pavement. Pavement shall not be disturbed without the written permission of the Engineer. Jacking and drilling pits shall be kept 2 ft (600 mm) clear of the edge of pavement.

3.3.7 When so directed, and whenever a continuous traffic signal conduit line is greater than 90 ft (25 m), additional pull boxes shall be installed. Cable splices shall not be made in these boxes without permission.

3.3.8 A minimum of 3 ft (1 m) of space shall be left between the ends of conduit runs where there may be a future junction. When conduit is installed which does not terminate in a pull box, equipment base or similar type foundation, a witness marker consisting of a No. 5 re-bar of sufficient length to allow for the top of the marker to be set flush with the final grade shall be placed vertically at each end of such buried conduit.

3.3.9 Unless otherwise directed, a 14 gauge (2 mm) galvanized steel pull wire or plastic/nylon rope having a minimum tensile strength of 200 lb (900 N), shall be placed in all conduit runs. At least 24 inch (600 mm) of wire or rope shall be left coiled at each end of the conduit.

3.4 Backfilling.

3.4.1 All backfill material adjacent to conduit shall be approved material. Backfill material shall be free from hard lumps or clods larger than 3 inch (75 mm) in diameter and free from rocks and stumps. Backfill within the pavement structure shall be of the same type material and match the depths encountered.

3.4.2 When conduit is installed beyond traveled ways and shoulders, and outside of areas such as sidewalks and parking lots, the backfill shall be placed to 6 inch (150 mm) above the conduit and compacted by pneumatic tampers, vibratory compactors, or other approved means. The remainder of the backfill material shall then be placed and compacted by an approved method.

3.4.3 When conduit is installed within traveled ways, shoulders, sidewalks and parking areas, the backfill shall be placed to 6 in (150 mm) above the conduit or encasement and compacted by pneumatic tampers, vibratory compactors, or other approved means. Additional backfill shall be placed in layers not greater than 6 in (150 mm).

3.4.4 Bituminous or Portland Cement concrete pavement removed to excavate the trench shall be replaced with hot bituminous pavement conforming to the requirements of 401 unless otherwise directed. Pavement shall be placed in thoroughly compacted layers of not more than 2 inch (50 mm) to give a total thickness equal to that of the existing pavement. All backfill shall be compacted to not less than 95 percent of maximum density as determined by AASHTO T 99.

3.4.5 Conduits provided for future use shall have suitable plugs installed at each end. Conduit ends shall not be backfilled until reference measurements are made by the Engineer.

3.4.6 A plastic warning tape shall be installed over all conduits at approximately 12 inch (300 mm) below final grade.

3.5 Testing.

3.5.1 After the trench has been backfilled, excluding pavement if applicable, the Contractor, in the presence of the Engineer, shall test the installation by pushing through the entire length of the conduit line a device with a diameter not smaller than 1/4 inch (6 mm) less than the inside diameter of the conduit. All obstructions including stones, dirt, and the like, shall be removed. Broken or other unsatisfactory conduits shall be replaced at no expense to the Department.

3.5.2 When ordered, existing conduit to be incorporated into a new system shall be cleaned with a mandrel and blown out with compressed air.

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3.6 Pull Boxes.

3.6.1 Pull boxes within the limits of the traveled way, shoulders, whether paved or unpaved, parking lots, adjacent to slope curb, and within 10 ft. (3.0 m) of the edge of pavement shall be concrete and installed as shown on the plans and specified herein.

3.6.2 Pull boxes outside the limits of 3.6.1 shall be concrete or molded and installed as shown on the plans and specified herein.

3.6.3 All pull boxes shall be placed on a minimum of 6 in. (150 mm) of Granular Backfill conforming to 209.2.1 extending at least 4 in. (100 mm) beyond the outside of the pull box compacted to not less than 95 percent of maximum density as determined by AASHTO T 99. With the cover installed, soil shall be backfilled and compacted around the box. At final installation the box and cover shall be flush with finished grade.

3.6.4 Pullbox covers shall have a recessed logo indicating the type of service enclosed.

3.6.5 An approved 2 in. (50 mm) galvanized “J” hook shall be installed as directed in pull boxes designated to be used for traffic signal circuits.

Method of Measurement

4.1 Conduit will be measured by the linear foot (linear meter) of the specified type, size and number of ducts of the size required, to the nearest 0.1 of a foot (meter).

4.1.1 When a conduit is connected to a foundation for a signal pole, control cabinet pole, or light pole, measurement will be made only to 3 ft (1 m) from the center of the base, measured horizontally. The limit of measurement where conduit is joined to previously existing conduit will be at the junction of the two conduits.

4.2 Pull boxes will be measured by each, but will not be deducted from the length of the conduit.

Basis of Payment

5.1 The accepted quantities of conduit will be paid for at the contract unit price per linear foot (linear meter) of the type, size and number of ducts specified complete in place, including common structure excavation to the depth specified in 206.4.1, bedding if required, and backfill, with the following exceptions:

5.1.1 All rock structure excavation, any common structure excavation below the depth specified in 206.4.1, and any excavation of unsuitable material required below the conduit will be paid for under 206.

5.1.2 New material ordered for use as backfill below the subgrade to replace rock structure or unsuitable excavation will be paid for under 209.

5.1.3 Hot bituminous pavement required in 3.4.5 will be paid under 403. If the item of 403 is not included in the contract, this work will be paid as provided in 109.04.

5.2 The accepted quantities of pull boxes of the type specified will be paid for at the contract unit price per each.

5.2.1 No extra payment will be made for material specified in 3.6.3.

Pay items and units (ENGLISH):

614.121	2 inch Conduit, Concrete Encased	Linear Foot
614.131	3 inch Conduit, Concrete Encased	Linear Foot
614.132	3 inch 2-Duct Conduit, Concrete Encased	Linear Foot
614.133	3 inch 3-Duct Conduit, Concrete Encased	Linear Foot
614.141	4 inch Conduit, Concrete Encased	Linear Foot
614.142	4 inch 2-Duct Conduit, Concrete Encased	Linear Foot
614.3121	1-1/4 inch Steel Conduit	Linear Foot
614.321	2 inch Steel Conduit	Linear Foot
614.331	3 inch Steel Conduit	Linear Foot
614.3311	3 inch Steel Conduit, Jacked or Drilled	Linear Foot
614.341	4 inch Steel Conduit	Linear Foot
614.3411	4 inch Steel Conduit, Jacked or Drilled	Linear Foot
614.511	Concrete Pull Box - 14 inch	Each
614.512	Concrete Pull Box - 18 inch	Each
614.522	Molded Pull Box - 13 by 24 inch	Each
614.523	Molded Pull Box - 17 by 30 inch	Each
614.7214	2 inch PVC Plastic Conduit, Schedule 40	Linear Foot
614.7218	2 inch PVC Plastic Conduit, Schedule 80	Linear Foot
614.7224	2 inch 2-Duct PVC Plastic Conduit, Schedule 40	Linear Foot
614.7228	2 inch 2-Duct PVC Plastic Conduit, Schedule 80	Linear Foot
614.7314	3 in PVC Plastic Conduit, Schedule 40	Linear Foot
614.7318	3 inch PVC Plastic Conduit, Schedule 80	Linear Foot
614.7324	3 inch 2-Duct PVC Plastic Conduit, Schedule 40	Linear Foot
614.7328	3 inch 2-Duct PVC Plastic Conduit, Schedule 80	Linear Foot
614.7414	4 inch PVC Plastic Conduit, Schedule 40	Linear Foot
614.7418	4 inch PVC Plastic Conduit, Schedule 80	Linear Foot
614.83	Laying 3 inch Conduit	Linear Foot

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Pay items and units (METRIC):

614.121	50 mm Conduit, Concrete Encased	Linear Meter
614.131	75 mm Conduit, Concrete Encased	Linear Meter
614.1082	75 mm 2-Duct Conduit, Concrete Encased	Linear Meter
614.1083	75 mm 3-Duct Conduit, Concrete Encased	Linear Meter
614.1101	100 mm Conduit, Concrete Encased	Linear Meter
614.1102	100 mm 2-Duct Conduit, Concrete Encased	Linear Meter
614.3031	32 mm Steel Conduit	Linear Meter
614.3051	50 mm Steel Conduit	Linear Meter
614.3081	75 mm Steel Conduit	Linear Meter
614.30811	75 mm Steel Conduit, Jacked or Drilled	Linear Meter
614.3101	100 mm Steel Conduit	Linear Meter
614.31011	100 mm Steel Conduit, Jacked or Drilled	Linear Meter
614.511	Concrete Pull Box - 350 mm	Each
614.512	Concrete Pull Box - 450 mm	Each
614.522	Molded Pull Box - 325 by 600 mm	Each
614.523	Molded Pull Box - 425 by 750 mm	Each
614.70514	50 mm PVC Plastic Conduit, Schedule 40	Linear Meter
614.70518	50 mm PVC Plastic Conduit, Schedule 80	Linear Meter
614.70524	50 mm 2-Duct PVC Plastic Conduit, Schedule 40	Linear Meter
614.70528	50 mm 2-Duct PVC Plastic Conduit, Schedule 80	Linear Meter
614.70814	75 mm PVC Plastic Conduit, Schedule 40	Linear Meter
614.70818	75 mm PVC Plastic Conduit, Schedule 80	Linear Meter
614.70824	75 mm 2-Duct PVC Plastic Conduit, Schedule 40	Linear Meter
614.70828	75 mm 2-Duct PVC Plastic Conduit, Schedule 80	Linear Meter
614.71014	100 mm PVC Plastic Conduit, Schedule 40	Linear Meter
614.71018	100 mm PVC Plastic Conduit, Schedule 80	Linear Meter
614.808	Laying 75 mm Conduit	Linear Meter

SECTION 615 -- TRAFFIC SIGNS**Description**

1.1 This work shall consist of furnishing, erecting, relocating or removing traffic signs and sign supports as shown on the plans or as ordered.

1.2 Sign Types.

1.2.1 Traffic Signs Type A and Type AA shall be extruded aluminum plank traffic signs with retroreflective sheeting background and retroreflectorized demountable cut-out copy. Type A shall include I-beam mounts and hardware as shown on the plans.

1.2.2 Traffic Signs Type B and Type BB shall be flat sheet aluminum signs with retroreflective sheeting background and retroreflectorized cut-out copy. Type B shall include aluminum tube mounts or steel "U" post mounts or as shown on the plans.

1.2.3 Traffic Signs Type C and Type CC shall be flat sheet aluminum signs with retroreflective sheeting background and non-embossed copy unless otherwise shown on plans. Type C signs shall include aluminum tube mounts or steel "U" post mounts or as shown on the plans.

Materials

2.1 All parts used in constructing signs shall be designed to withstand a wind loading of 35 pounds per square foot (1.7 kPa) on the sign surface, unless otherwise noted on the plans.

2.2 Extruded aluminum planks shall be of the butt type, 6 or 12 in (150 or 300 mm) wide and of the lengths indicated on the plans. Edge moldings are optional and if furnished shall match the panels and shall have a natural aluminum finish. Aluminum panels shall conform to the requirements of ASTM B 221 (ASTM B 221 M), Alloy 6061-T6. Aluminum molding may be of T5 or T6 temper.

2.3 Flat aluminum sheets for sheet signs shall be one piece and conform to ASTM B 209 (ASTM B 209 M), Alloy 6061-T6 or Alloy 5052-H38. The minimum thickness of the sheets up to 36 in (900 mm) wide shall be 0.080 in (2 mm). Signs greater than 36 in (900 mm) shall be a minimum of 0.100 in (2.5 mm).

2.3.1 Plywood sheet signs shall be standard form (BB grade or better), minimum 0.5 in (12.5 mm), exterior type with both faces of medium density overlay (MDO) as described in Voluntary Product Standard "PS-1-95 Construction and Industrial Plywood", National Institute of Standards & Technology. The edges of the plywood signs shall be sealed by painting them with a sealer.

2.4 Demountable sign copy shall conform to ASTM B 209 (ASTM B 209M), Alloy 3003-H14. The minimum thickness of flat sheet aluminum shall be 0.032 in (0.8 mm).

2.5 Posts.

2.5.1 Steel posts shall conform to ASTM A 36/A 36M or ASTM A 572/A 572M and unless otherwise shown on the plans, shall be galvanized in accordance with AASHTO M 111 (ASTM A 123).

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2.5.1.1 The total maximum weight of steel posts below the hinges of a breakaway support system shall not exceed 45 pounds per foot (67 kilograms per meter) when 2 posts are to be placed within 7 ft (2.1 m) of each other.

2.5.2 Aluminum posts for non-breakaway supports shall be of a standard shape aluminum tubing conforming to ASTM B 221 (ASTM B 221 M), Alloy 6061-T6 or 6063-T6, as shown on the plans. The wall thickness shall be a minimum of 1/8 in (3 mm)mm and a maximum of 3/16 in (5 mm).

2.5.2.1 Aluminum posts for use with breakaway support systems shall conform to ASTM B 429, Alloy 6061-T6 or 6063-T6, Schedule 40, as shown on the plans.

2.5.3 Steel “U” posts shall be rail steel conforming to the requirements of ASTM A 499, Grade 60 or ASTM A 576, Grade 1070-1080, minimum yield strength of 60,000 psi (413.6 MPa). Posts shall be galvanized in accordance with AASHTO M 111. The weight per foot (meter) shall be a minimum of 2-1/2 lb (3.7 kg) and a maximum of 3 lb (4.5 kg). The posts shall have 3/8 in (9.5 mm) holes drilled or punched, before painting, along the center line of the web. The holes shall begin 1 in (25 mm) from the top of post and continue at 1 in (25 mm) centers for the entire length of the post.

2.6 Overhead traffic sign structures shall be galvanized steel designed in accordance with 3.4.1.

2.7 Hardware for signs shall conform to the NHDOT Standard Plans for Road and Bridge Construction.

2.7.1 The extruded plank post clip assembly shall be stainless steel bolt Alloy 304 ASTM A 193/ASTM A193M Grade B8, stainless steel stop nut Alloy 304 ASTM A-194/ASTM A194M Grade 8 with nylon filler and stainless steel M10 flat washer Alloy 302 ASTM –A 276.

2.7.2 The extruded plank attachment assembly shall be stainless steel hex bolt Alloy 304 ASTM A193/ASTM A193M Grade B8, stainless steel hex nut Alloy 304 ASTM A-194/ASTM A194M Grade 8 and stainless steel M10 flat washer Alloy 302 ASTM-A276.

2.7.3 The bolt assembly for the post clamp shall be stainless steel cap screw Alloy 304 ASTM A193/ASTM A193M Grade B8, stainless steel locknut Alloy 304 ASTM A194/ASTM A194M Grade 8 with nylon filler and stainless steel M10 flat washer Alloy 302 ASTM-A276. The finish on the clamps shall be Electro-Galvanized clamp. Hardware shall be Unistrut P1120 EG or approved equal. The channel bracket shall be pregalvanized conforming to ASTM D653 G90, and steel conforming to ASTM A653 GR 33 without perforations. Hardware shall be Unistrut P4100 PG or approved equal.

2.7.4 The U-channel post assembly shall be stainless steel hex bolt Alloy 304 ASTM A193M/ASTM A193 Grade B8, stainless steel M10 fender washer and flat washer Alloy 302 ASTM-A276, a nylon washer, and stainless steel locknut Alloy 304 ASTM A194/ASTM A194M Grade 8 with nylon filler.

2.8 Supports, Bases, and Anchors.

2.8.1 Breakaway support systems shall conform to the AASHTO “Standard Specifications for Structural Supports for Highway Traffic Signs, Luminaries and Traffic Signals” as shown on the plans.

2.8.2 Concrete for bases shall be Class B and shall conform to 520. Reinforcing steel shall conform to 544.

2.8.3 Anchor bolts for overhead sign structure shall be steel conforming to AASHTO M 314, Grade 36 (250), 55 (380) or 105 (725) and shall be hot-dip galvanized for a minimum of 16 in (400 mm)

on the threaded end in accordance with AASHTO M 232/M 232M, Class C. Nuts shall conform to AASHTO M 291/M 291M. Washers shall conform to AASHTO M 293. Nuts and washers shall be galvanized in accordance with AASHTO M 232/M 232M, Class C or AASHTO M298, Class 50.

2.8.4 Anchors for aluminum posts shall conform to the materials shown in the NHDOT Standard Plans for Road and Bridge Construction.

2.8.5 Anchors for breakaway systems for ground-mounted sign supports shall be stainless steel Type 304 in accordance with ASTM A 276. Anchor bolts for breakaway systems shall be steel in accordance with AASHTO M 164/M 164M, galvanized in accordance with AASHTO M 232/M 232M, Class C or AASHTO M 298, Class 50.

2.9 Copy (Text and Borders).

2.9.1 Copy for Type A, and Type AA Signs.

2.9.1.1 The letters, numerals, symbols, shields, and borders of retroreflective sheeting permanently adhered to flat sheet aluminum backing shall be adhesive coated Type III retroreflective sheeting conforming to 718 Retroreflective Sheeting.

2.9.1.2 The design, arrangement, color, and spacing of copy shall be as shown on the plans, in the MUTCD and the Standard Highway Signs book.

2.9.1.3 Spacing of mounting holes for demountable copy shall be determined by character size and shape, but in no case shall be more than 8 in (200 mm) on center.

2.9.1.4 There shall be no gaps in the borders of the signs.

2.9.2 Copy for Type B and Type BB Signs.

2.9.2.1 The letters, numerals, symbols, shields, and borders of retroreflective sheeting shall be cut-out adhesive coated Type III retroreflective sheeting conforming to 718 Retroreflective Sheeting.

2.9.2.2 The design, arrangement, color, and spacing of copy shall be as shown on the plans, NHDOT Standard Plans for Road and Bridge Construction, in the MUTCD and the Standard Highway Signs book.

2.9.2.3 There shall be no gaps in the borders of the signs.

2.9.3 Copy for Type C and Type CC Signs.

2.9.3.1 Copy for Type C and Type CC signs shall be cut-out or silk screened . Cut –out copy or ink for the silk screened shall be approved by background retroreflective sheeting manufacture for use on their sheeting.

2.9.3.2 Design and colors shall be as shown on the plans, NHDOT Standard Plans for Road and Bridge Construction, the MUTCD and the Standard Highway Signs book.

2.9.3.3 There shall be no gaps in the borders of the signs.

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2.10 Background

2.10.1 Type A, AA, B and BB signs.

2.10.1.1 All background sheeting shall be retroreflective sheeting conforming to 718 Retroreflective Sheeting. Visual inspections to assure that sheeting meets the specified requirements may be made by the Engineer at any time prior to acceptance.

2.10.1.2 Type B signs and shields for Interstate or Turnpikes may utilize overlay film conforming to 718 retroreflective sheeting. Visual inspections to assure that the films meet the specified requirements may be made by the Engineer at anytime prior to acceptance. Signs shall be rejected and replaced if the film has any blistering, tears, or fading. If the film is rejected, the Engineer may require the Contractor to replace the sign completely with sheeting and no overlay film. Sheeting warranty shall not be void due to the type of film applied over the sheeting. Certificate of compliance of sheeting and film shall be submitted to the Engineer per 2.11.

2.10.2 Type C and CC signs.

2.10.2.1 All background sheeting shall be retroreflective sheeting conforming to 718 Retroreflective Sheeting.

2.11 Certificates of compliance for all sheeting materials shall be furnished in accordance with 106.04 and 718.

Construction Requirements

3.1 General.

3.1.1 The plans will show cross sections of the highway in the area of overhead structures, the dimensions of the signs to be mounted, and the approximate locations, but the exact locations shall be as determined by the Engineer.

3.1.2 The length of posts may vary from the plan length to fit the final designed sign location and the Contractor is cautioned to take this contingency into account.

3.1.3 Traffic sign details not shown on the plans shall conform to the MUTCD and Standard Highway Signs book. Traffic sign supports and framing members shall be in accordance with the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals".

3.2 Manufacture and Assembly.

3.2.1 Preparation of planks. Prior to application of the retroreflective sheeting, planks shall have been completely fabricated with all necessary holes drilled or punched. The planks shall be carefully and thoroughly degreased and dried in accordance with the sheeting manufacturer's recommended practice.

3.2.2 Preparation of aluminum sheets. Prior to the application of the retroreflective sheeting, the aluminum sheets shall be one piece except as indicated in 3.2.2.2 and have been cut to the required sizes, with the corners at the prescribed radii, with true and smooth edges, and shall be free of burrs or ragged breaks.

3.2.2.1 The aluminum shall be properly degreased and etched or treated in accordance with ASTM B 449, Class 2.

3.2.2.2 Sign splices may be necessary for aluminum sheet signs with a width greater than 5 ft (1.5 m) and height greater than 5 ft (1.5 m). The splice shall always be horizontal. The two aluminum pieces to be joined shall have square corners at the joint and shall be butted together and joined on the back with a piece of aluminum sheeting a minimum 8 in (200 mm) in height for the total width of the sign. This piece of aluminum shall be equally divided between both sides of the joint and riveted from the front approximately every 4 in (100 mm) to 6 in (150 mm) on each side of the joint. The splice shall be the same thickness as the aluminum sign. Rivets are to be the same color as the sign sheeting it is riveted to. Silver can be used for white sheeting. A channel bracket shall be bolted in the vicinity of this splice.

3.2.3 The retroreflective sheeting shall be of the colors provided in the MUTCD, Standard Highway Signs book, NHDOT Standard Plans for Road and Bridge Construction or as shown on the plans.

3.2.4 The Contractor shall submit drawings for approval showing arrangements, spacing, radii, border widths, indent spacing and colors of copy and type of retroreflective sheeting.

3.2.5 Application of retroreflective sheeting to aluminum plank. The sheeting shall be applied to the face of the extruded aluminum planks by a squeeze roller applicator in accordance with the recommendations of the sheeting manufacturer. The face of the planks shall be completely covered by the retroreflective sheeting. Borders of pressure-sensitive adhesive type retroreflective sheeting shall be applied by means of a 2 in (50 mm) rubber hand roller as recommended by the sheeting manufacturer. All signs shall contain the date of manufacture and size, located in the lower left corner of the front face of the sign (i.e. 3-90 10'x15'). Letters and numbers shall be 2 in (50 mm) non-reflective white adhesive pressure copy.

3.2.5.1 Whenever a sign face comprises two or more pieces of retroreflective sheeting, they shall be carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance both day and night, and shall have a minimum overlap of 3 in (75 mm). Alternate, successive width sections of either sheeting or planks shall be reversed and placed consecutively to insure that corresponding edges of retroreflective sheeting lie adjacent on the finished sign.

3.2.6 Application of retroreflective sheeting to aluminum sheets. The sheets shall conform to the provisions of aluminum plank except that the sheeting shall be applied to the aluminum either by the heat vacuum applicator method or by mechanical roller application in accordance with the recommendations of the sheeting manufacturer and shall have a minimum overlap of 1 in (25 mm) with the top sheeting overlapping the bottom sheeting. All Type B signs shall contain the date of manufacture and size, located in the lower left corner of the front face of the sign (i.e. 3-90 10'x15'). Letters and numbers shall be 1 in (25 mm) non-reflective white adhesive pressure copy. All Type C signs shall contain a legible size and date of manufacture, located in the lower right corner on the back of the sign, applied with permanent marker, paint, or stickers (i.e. 9-04, 3'x3').

3.2.7 Application of Sign Copy.

3.2.7.1 Application of copy for Type A and Type AA shall be retroreflectorized demountable sign copy and shall be applied to the panels by using aluminum rivets or aluminum alloy sheet metal screws conforming to ASTM B 211M (ASTM B 211), Alloy 2024. Screws and rivets are to be the same color as the sign copy. Silver can be used for white sheeting.

3.2.7.2 Application of copy for Type B and Type BB traffic signs shall be adhesive back pressure sensitive cut-out copy applied by a roller application (hand or machine).

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3.2.7.3 Application of copy for Type C and Type CC traffic signs shall be cut-out or silk screened as specified by the sheeting manufacturer. Non-adhesive cut-out copy shall be bonded to the sign surface by the heat vacuum applicator method.

3.2.8 Appearance. Any damage to the retroreflective sheeting appearing in the completed sign shall be cause for rejection. Patching will not be permitted.

3.3 Installation of Traffic Signs.

3.3.1 The top edges of all signs shall be horizontal. Any chipping or bending of sign panels shall be cause for replacement at the Contractor's expense.

3.3.2 Ground-mounted signs shall be erected to face 2 degrees away from the direction of approaching traffic. Overhead mounted signs shall be erected to face downward 5 degrees from vertical.

3.3.3 The minimum sign height for a conventional road sign in a rural district shall be 6 feet. All other sign heights shall be in accordance with the MUTCD.

3.3.4 When two (2) or more signs are installed on the same supports, the signs shall be butted together unless otherwise specified on the plans or MUTCD. There shall be no gaps between the signs.

3.4 Overhead Traffic Sign Structures.

3.4.1 Overhead sign structures shall be designed in accordance with the AASHTO 2001 "Standard Specifications for Structural Supports for Highway Traffic Signs, Luminaries and Traffic Signals" including all interims except as modified herein. Structures shall be designed to accommodate sign surface areas of 30 percent greater than those shown on the plans. Sign structures shall be designed based on the following criteria:

Basic Wind Speed: 105 mph (170 km/h)

Design Life: 50 Years

Fatigue Importance Category: Category II (Category I for cantilever sign structures, span >30')

Natural Wind Gust Loading, Galloping loads (except for cantilevered four chord trusses), and Truck Induced Gust Loading shall be considered.

Vortex shedding effects do not need to be considered.

Overhead signs shall provide a vertical clearance of not less than 17 feet – 6 inches (5.4 m) over the entire width of the pavement and shoulders. Three (3) foot interior walkways, with OSHA approved railing, shall be provided for access to the back side of variable or dynamic message signs on overhead sign structures. For full overhead traffic sign structures the anchor bolt size and pattern shall be identical for both bases.

3.4.1.1 The Contractor shall furnish the design calculations, complete shop drawings or manufacturer's standard specifications and drawings, or both for the overhead structure proposed to be erected, including method of attaching signs to the structure for documentation in accordance with 105.02. The Contractor shall also supply, along with any pertinent design calculations, a list of the following forces at the top of each foundation:

Truss or Cantilever Dead Load

Sign(s) Dead Load

Post(s) Dead Load

Wind Load on the Horizontal Sign Support

Wind Load on the Sign(s)

Wind Load on the Post(s)
Ice Load on the Horizontal Sign Support
Ice Load on the Sign(s)

Details of bases for overhead structures will be furnished to the Contractor after submittal of the shop drawings.

3.4.2 Triangular truss type overhead traffic sign structures shall not be permitted.

3.4.3 Concrete shall be constructed in accordance with 520. Reinforcing steel shall be constructed in accordance with 544.

3.4.4 Backfill shall be constructed in accordance with 209 or 508 as called for on the plans. ,

3.4.5 Supporting columns shall not be mounted on the leveling nuts until the concrete has cured for at least 7 days or attained a minimum of at least 80 percent of its design compressive strength. Grout shall be provided between the footings and the column bases.

3.4.6 When the sign panels are not to be installed immediately upon completion of the structure, an equivalent loading of the structure shall be provided.

3.4.7 Sign mounting brackets shall be attached to the structure utilizing only bolted connections, which allow complete lateral and vertical adjustment of the sign over the roadway.

3.4.8 The applicable provisions of 550.3 shall apply to sign structures.

3.4.9 When overhead sign structures are ordered removed or relocated, the entire structure, mounting brackets, signs, and bases down to 1 foot (300 mm) below final ground level, shall be removed. Unless otherwise shown on the plans, the structure removed shall become the property of the Contractor.

3.4.10 Sheeting and shoring, if required, shall conform to the applicable provisions of 503 and 506, as appropriate.

3.5 Traffic Signs Type A.

3.5.1 The posts for traffic sign mounts shall be set in the foundation holes and securely held in place by a brace or template before the concrete for the base is placed. All posts shall be plumb and properly oriented with the roadway. Flanges supporting a single sign will lay in the same plane.

3.5.1.1 The forms and templates supporting the posts shall not be removed until the concrete has cured at least 24 hours. No sign shall be attached to the posts until the concrete has cured as provided in 3.4.5.

3.5.2 After erection, all bare steel shall be thoroughly wire brushed or power-tool cleaned and covered with 2 coats of zinc-rich primer. The first coat shall be thoroughly dry before the second coat is applied.

3.5.3 When rock is encountered in erecting posts, the depth to be drilled into the rock and any required grouting shall be as directed and subsidiary to the item.

3.5.4 Sign panels shall be mounted horizontally on the posts as shown on the plans. The back of the panels shall be flush with the posts after the mounting is completed.

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3.5.5 When Type A signs are ordered removed, the entire assembly including the footings down to 1 ft (300 mm) below ground level shall be removed. Unless otherwise shown on the plans, the steel and sign panels shall become the property of the Contractor.

3.5.6 When Type A signs are ordered relocated, new steel posts and all necessary mounting hardware shall be provided unless otherwise shown on the plans. Unless otherwise shown on the plans, removed steel shall become the property of the Contractor.

3.5.7 When Type AA bridge mounted signs are ordered to be removed, the bolt holes shall be filled and painted as directed. Unless otherwise shown on the plans, the steel and sign panels shall become the property of the Contractor.

3.5.8 When Type AA signs are ordered to be relocated, all new mounting hardware shall be included to attach to existing structures on posts. Bridge mounted structures and overhead structures' vertical support braces shall be trimmed to match signs.

3.6 Traffic Signs Type B and C.

3.6.1 Aluminum posts shall be set in holes excavated to the proper depth. The anchors shall be constructed as shown on the plans. After inserting posts, the holes shall be backfilled with granular material placed in thoroughly compacted layers not exceeding 6 in (150 mm) in depth, care being taken to preserve the alignment of the posts. When more than one post per sign is required, the posts shall be parallel and plumb. Posts bent or otherwise damaged shall be removed and replaced.

3.6.2 Steel "U" posts may be set as specified in 3.6.1 or driven.

3.6.2.1 When posts are driven, a suitable driving cap shall be used. Battered heads will not be accepted. Posts shall not be driven with the assembly or sign attached.

3.6.3 When rock is encountered in erecting posts, the depth to be drilled into the rock and any required grouting shall be as directed and subsidiary to the item.

3.6.4 When Type B or C signs are ordered removed, the sign and posts shall become the property of the Contractor, unless otherwise shown on the plans. Any existing concrete foundation shall be removed down to 1 ft (300 mm) below final grade elevation.

3.6.5 When Type B or C signs are ordered relocated, new posts and all necessary mounting hardware, including breakaway bases if required, shall be provided.

Method of Measurement

4.1 Overhead traffic sign structures including bridge mounts, will be measured as a unit. When more than one unit is specified in the contract, separate item numbers will appear for each separate unit.

4.1.1 Removing overhead traffic sign structures will be measured as a unit, including the removal of the signs and sign bases as shown or ordered.

4.1.2 Relocating overhead traffic sign structures will be measured as a unit, including new anchor bolts and the removal of existing sign bases as shown or ordered.

4.2 Traffic sign Type A, B, C, AA, BB or CC will not be measured, but shall be the square foot (square meter) final pay quantities in accordance with 109.11 for traffic signs required as shown on the plans, including all necessary posts, footings, and mounting hardware.

4.2.1 Removing traffic sign Type A or AA will be measured as a unit. A unit will include all footings to a minimum of 1 ft (300 mm) below finished grade, posts, mounting hardware including bridge mounts, and all signs on the same post.

4.2.2 Removing traffic signs Type B, C, BB or CC shall be subsidiary unless otherwise noted. Removal will include all footings (to a minimum of one foot (300 mm) below finished grade, posts, mounting hardware and all signs on each post.

4.2.3 Relocating traffic sign Type A, B, C, AA, BB or CC will be measured as a unit. A unit will include removing footings and posts, furnishing new footings, posts and mounting hardware, trimming existing bridge mounted structures and overhead structural vertical support brace, and all signs on the new post(s).

Basis of Payment

5.1 Overhead traffic sign structures will be paid at the contract lump sum price complete in place with the following stipulations:

5.1.1 Structure excavation for bases will be paid under 206.

5.1.2 Concrete required will be paid for under 520.

5.1.3 Reinforcing steel required will be paid for under 544.

5.1.4 Overhead traffic sign structures removed or relocated will be paid at the contract lump sum price.

5.1.5 Sheeting and shoring for sign structures will be paid for under the appropriate items of 503 or 506 as indicated on the plans. When not included as a bid item this work will be subsidiary to the structure item.

5.2 Traffic sign type A, B, C, AA, BB or CC are final pay quantity items and will be paid for at the contract unit price per square foot (square meter) complete in place in accordance with 109.11.

5.2.1 The accepted quantities of removing traffic sign Type A or AA or relocating traffic sign Type A, B, C, AA, BB or CC will be paid for at the contract unit price per each unit.

Pay items and units:

615.002	Breakaway Mounts	Unit
615.0071	Steel Sign Posts	Pound (Kilogram)
615.0072	Steel Breakaway Sign Posts	Pound (Kilogram)
615.0073	Aluminum Sign Posts	Pound (Kilogram)

KEY TO ITEM NUMBERS FOR SIGN STRUCTURES AND SIGNS

Item Number	Unit
615 .A B C DE	Item Number
615	Section Number
.A	Class of Structure
B	Sign Type

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C DE		Treatment Identification or Location Number	
A	Class of Structure		Unit
.1	Full Traffic Sign Structure		Unit
.2	Cantilever Traffic Sign Structure		Unit
.3	Bridge Mounted Traffic Sign Structure		Unit
.4	Span Wire Traffic Sign Structure		Unit
B	Sign Type		
.01	Traffic Sign Type A	Square Foot (Square Meter)	
.02	Traffic Sign Type B	Square Foot (Square Meter)	
.03	Traffic Sign Type C	Square Foot (Square Meter)	
.04	Traffic Sign Type AA	Square Foot (Square Meter)	
.05	Traffic Sign Type BB	Square Foot (Square Meter)	
.06	Traffic Sign Type CC	Square Foot (Square Meter)	
	C	Treatment	
	--1	Open	
	--2	Breakaway Mounts	Unit
	--3	Removing	Unit
	--4	Relocating	Unit
	--5	On Existing Facilities	
	--6	On New Facilities	
--8	Reset		
	DE	Identification and Location	
	---	01	
	---	99	
615.01	Traffic Sign Type A (F)	Square Foot (Square Meter)	
615.012	Traffic Sign Type A, Breakaway Mounts (F)	Square Foot (Square Meter)	
615.012	Traffic Sign Type A, Breakaway Mounts	Square Foot (Square Meter)	
615.013	Removing Traffic Sign Type A	Unit	
615.014	Relocating Traffic Sign Type A	Unit	
615.02	Traffic Sign Type B (F)	Square Foot (Square Meter)	
615.022	Traffic Sign Type B, Breakaway Mounts (F)	Square Foot (Square Meter)	
615.024	Relocating Traffic Sign Type B	Unit	
615.03	Traffic Sign Type C (F)	Square Foot (Square Meter)	
615.032	Traffic Sign Type C, Breakaway Mounts (F)	Square Foot (Square Meter)	
615.034	Relocating Traffic Sign Type C	Unit	
615.04	Traffic Sign Type AA (F)	Square Foot (Square Meter)	
615.043	Removing Traffic Sign Type AA	Unit	
615.044	Relocating Traffic Sign Type AA	Unit	
615.05	Traffic Sign Type BB (F)	Square Foot (Square Meter)	
615.054	Relocating Traffic Sign Type BB	Unit	
615.06	Traffic Sign Type CC (F)	Square Foot (Square Meter)	
615.064	Relocating Traffic Sign Type CC	Unit	

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615.10001	Full Traffic Sign Structure	Unit
615.10005	Full Traffic Sign Structure	Unit
615.20001	Cantilever Traffic Sign Structure	Unit
615.20007	Cantilever Traffic Sign Structure	Unit
615.30001	Bridge Mounted Traffic Sign Structure	Unit
615.30005	Bridge Mounted Traffic Sign Structure	Unit
615.30301	Removing Bridge Mounted Traffic Sign Structure	Unit
615.30305	Removing Bridge Mounted Traffic Sign Structure	Unit
615.30801	Reset Bridge Mounted Traffic Sign Structure	Unit
615.30805	Reset Bridge Mounted Traffic Sign Structure	Unit
615.40001	Span Wire Traffic Sign Structure	Unit
615.40005	Span Wire Traffic Sign Structure	Unit
615.40301	Removing Span Wire Sign Structure	Unit
615.40401	Relocating Span Wire Sign Structure	Unit

SECTION 616 -- TRAFFIC SIGNALS

Description

1.1 This work shall consist of furnishing and installing traffic signals, pedestrian signals, or flashing beacons including poles, mast arms, foundations, and all necessary fittings, cables, and components ordered.

1.2 Traffic signal terms shall be in accordance with those defined in the MUTCD.

Materials

2.1 A list of the recommended materials required to install the system may be included as an amendment to this specification, but the Department will give no guarantee as to the completeness of this list.

2.1.1 Electrical materials shall meet the standards herein, local and utility codes, and the National Electrical Code, where applicable.

2.1.2 Drawings, manufacturer's specifications, and applicable catalog cuts for all materials and components shall be submitted in accordance with 105.02 within 21 days after award of the contract. An additional set of final approved documents, to total 6 sets, shall be supplied to the Engineer.

2.2 Traffic Signal Heads.

2.2.1 Housings. Housings shall be constructed of die cast aluminum or polycarbonate with a smooth outer surface and shall be capable of holding the optical units securely in place. Housings shall be adaptable for pedestal, bracket, or rigid mast-arm vertical or horizontal mounting. The assembled housing shall be dust proof and moisture proof. Each housing shall be equipped with a hinged door of die cast aluminum or polycarbonate to hold the lens and parts of the optical units. The doors shall be designed to insure uniform pressure around the door frame when closed. Doors shall be fastened by

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hinged wing nut assemblies or other approved fasteners. Unless otherwise indicated on the plans, lenses shall be furnished with approved sun shield visors, not less than 10 in (250 mm) in length. If either longer visors than those specified above or louvers are deemed necessary, they shall be furnished and installed. All traffic signals except programmed signals shall be furnished with a 5+ in (125 mm) backplate. Backplates shall be fastened with stainless steel hex head slotted screws and a 3/16 in by 3/4 inch (5 by 19 mm) stainless steel fender washer.

2.2.1.1 The assembled housings shall be made up of individual sections fastened together with bolts. The assembly of sectional units shall present a smooth unbroken contour of pleasing appearance. Each end of the housing assembly shall have an opening for a 1-1/2 in (38 mm) pipe nipple. The area around this opening shall be reinforced and serrated so that lock nuts will seat firmly.

2.2.1.2 One cap shall be supplied with each assembled housing to act as a cover over the hole in the top to prevent water from entering.

2.2.2 Housing adapters. Housing adapters for pedestal mounting shall be constructed of metal. They shall be adjustable with serrated surfaces to permit the housing to be locked in the desired horizontal position. The adapters shall be secured to the bottom of the housing by means of a close nipple, shall slip-fit at least 7 inch (175 mm) over a standard traffic signal post 4 inch (100 mm) in diameter, and shall be secured to the post by means of set screws. Adapters shall contain raceways from the housing to the post to protect the wires from the elements.

2.2.3 Mast arm brackets. Mast arm brackets shall be as indicated in the recommended list of materials shown in the proposal.

2.2.4 Receptacles. The lamp receptacle shall be of heat resisting material designed to hold an A-21 bulb or 60 to 150 watt traffic signal lamp with the light center at the focal point of the reflector. This receptacle shall be provided with a lamp grip to prevent the lamp working loose due to vibration. Provision shall be made on either the lamp receptacle or reflector holder to permit the proper focusing of lamps, with a secure fastening provided to retain the desired focus.

2.2.4.1 Each receptacle shall be wired with two leads which shall terminate in a junction block in each signal head. Separate leads shall be used to wire the block to the base. Leads shall be 18 AWG stranded wire. All colors shall be bright and clearly defined and cover the insulation the entire length of the lead. The color of these leads shall be as follows:

- (a) From the receptacle behind the red lens: one red wire and one white wire with a red tracer;
- (b) From the receptacle behind the yellow lens: one yellow wire and one white wire with a yellow tracer;
- (c) From the receptacle behind the green lens: one green wire and one white wire with a green tracer;
- (d) From the receptacle behind the green arrow: one blue wire and one white wire with a blue tracer.

2.2.5 Optics. Optical units shall consist of certified 10,000 hour lamps, receptacles, reflectors, lenses, and other necessary equipment giving clearly visible signal indications within an angle of at least 45 degrees and at distances from 10 to 300 ft (3 to 90 m) under all normal light and atmospheric conditions. The units shall be designed to minimize the effect of all phantom light. The units shall be readily accessible for maintenance.

2.2.5.1 Reflectors shall reflect parallel light rays from a properly focused traffic lamp. Reflectors shall be constructed of one-piece polished alzak aluminum.

2.2.5.2 Lenses shall conform to the standards set forth by the Institute of Transportation Engineers and shall be of the color indicated, circular in shape, with a visible diameter of approximately 12 inch (300 mm). Each lens shall be true to color, of lexan material, free from imperfections, of high luminous transmission, conforming to the standards of ANSI D 101. Lens configuration shall be as specified in the MUTCD.

2.3 Pedestrian Signal Heads.

2.3.1 General. Pedestrian signal heads shall be of the incandescent type conforming to the Institute of Transportation Engineers Standard for Adjustable Face Pedestrian Signal Heads. All heads shall be rectangular in shape and shall consist of the lettered messages WALK and DONT WALK. Both messages shall be contained in a single section head. The light source shall be designed so that in case of an electrical or mechanical failure of the word DONT, the word WALK of the DONT WALK message shall also remain dark.

2.3.2 Housings. Housings shall be one piece die cast aluminum alloy complete with top, bottom, sides, and back. For mounting purposes, the top and bottom of the housing shall have openings to accommodate standard 1-1/2 inch (38 mm) pipe brackets. The outside surface of the openings shall be serrated to provide for positive positioning of the housing. Doors and fasteners shall be as specified in 2.2.1. The completed assembly shall be dust and moisture proof.

2.3.3 Lamps and receptacles. The pedestrian signal head shall be furnished complete with A-21 traffic signal lamps and compatible receptacles. Receptacles shall be of molded bakelite, molded phenolic, or ceramic and shall have a brass screw shell and adjustable lamp grip to allow positioning of the lamp. Receptacles shall be centered and pre-focused.

2.3.3.1 Each lamp receptacle shall be provided with one colored 18 AWG lead from the receptacle and one white 18 AWG lead from the screw shell to a terminal block mounted within the housing.

2.3.4 Lenses. The inside face of each lens within the message section area shall be painted with an approved transparent color to produce a Portland orange DONT WALK message and a lunar white WALK message when illuminated by the lamp. All areas surrounding the letters shall be opaque black. The letters shall be at least 4-1/2 inch (114 mm) in height with a stroke width of 5/8 inch (16 mm). When not illuminated, neither message shall be readily distinguishable.

2.4 Traffic Signal Poles, Mast Arms, and Pedestals.

2.4.1 General. Traffic signal structures shall be designed in accordance with the AASHTO 2001 "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals" including all interims except as modified herein. Traffic signal mast arms shall be designed, to support fixed signals, video detection equipment, signs, fire pre-emption equipment, and luminaries as shown on the plans. Minimum clearance to the bottom of overhead signal housings shall be 16 ft (4.9 m). Signal mast arm structures shall be designed based on the following criteria:

Basic Wind Speed: 105 mph (170 km/h)

Design Life: 50 Years

Fatigue Importance Category: Category II

Natural Wind Gust Loading shall be considered

Truck Induced Gust Loading, Galloping Loads and vortex shedding effects do not need to be considered.

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2.4.1.1 Steel structures, unless otherwise indicated, shall be hot dip galvanized in accordance with ASTM A 123.

2.4.1.2 Concrete foundation shall be concrete Class B meeting the requirements of 520. Reinforcing steel shall meet the requirements of 544. The foundation shall be as shown on the plans.

2.4.1.3 Anchor bolts shall conform to ASTM A 36/A 36M, Grade 55, having minimum yield strength of 55 ksi (379 Mpa) with threaded end and hex nuts (2 per bolt), galvanized in accordance with ASTM A 153.

2.4.1.4 Mast-arm structure design calculations and shop drawings shall be submitted for documentation in accordance with 105.02.

2.4.1.5 Wood poles shall be Class IV, with a fiber bending stress of 8,000 psi, to a length specified conforming to Rural Electrification Administration (REA) Specification DT-5C.

2.4.1.6 Messenger cable and guy cable shall be seven strand wire with a breaking strength of 8,000 pounds, double galvanized in accordance with AASHTO M 111.

2.5 Traffic Signal Controllers and Cabinets.

2.5.1 General. The controller shall operate on 120 volt, 60 hertz (cycle) alternating current, and shall be delivered completely wired and enclosed in a weatherproof cabinet. All components shall be new, and unless noted, the use of solid state components shall be required. Controllers shall be programmable, menu driven, traffic actuated complying with NEMA Standard TS-1, with time base coordination module, overlaps internally generated by means of an overlap card as per NEMA Standard TS-1, with wire jumpers on a printed circuit board, internal Fire pre-emption module with "D" connector harness and capable of providing an exclusive pedestrian phase as part of phase one.

2.5.1.1 All 8 phase controllers shall be wired to flash yellow in phase 2 and phase 6, and red in all other phases. Following an interruption of power all eight phase controllers shall start in a flashing mode of operation and will begin automatic operations at the beginning of the green period for phase 2 and phase 6.

2.5.1.2 Bench test. All components of the controller and cabinet shall be bench tested for a minimum of 72 continuous hours by the Contractor at the Contractor's facility prior to delivery to the project. A representative of the Bureau of Traffic shall verify the test check list. The Contractor shall notify the Engineer at least 3 days prior to testing as to the date, time and place that tests are to be performed. Testing shall be performed by a qualified Signal Technician using a testboard and in conformance with the design loads, phasings, timings and auxiliary equipment such as pre-emptions and pedestrian phases. Any defective component shall be replaced, retested and continuous testing continued. Test results shall be documented on a check list as provided by the Bureau of Traffic and these results attested by the signature of the performing technician. Upon completion of satisfactory bench testing, a written approval will be supplied to the Contractor by the Engineer for delivery to the project only. This approval does not relieve the Contractor from ensuring proper operation of the equipment. The approval shall accompany the cabinet and controller when delivered to the project.

2.5.1.2.1 The check list will contain the following items:

- A. Install all of the equipment into the cabinet as required per the plans and specifications.
- B. Set the phase timings of the controller in accordance with plans.

- C. Wire in load lamps, minimum rating of 90 watts, to the load packs in simulation to the intersection as per the plans.
- D. Check all of the wiring connections for physical tightness.
- E. Power up the cabinet.
- F. Observe the sequences, timings and operations of the controller in conformance to the plans and specifications.
- G. Using the phase test push buttons, insert a call for a phase and observe this phase as it is being called for sequencing, timing and returning to rest condition. Only one separate call for each phase shall be used.
- H. Using the pedestrian test push buttons, insert a call for each pedestrian phase and observe this phase as it is being called for sequencing, timing and returning to rest condition.
- I. Test the police panel switches, manual, on/off, flash/auto and test the police manual cord if present in the panel.
- J. When applicable test the pre-emptions as follows:
 - 1. Fire Pre-emption
 - Optical Detector - With the receivers wired in the cabinet and using an emitter, test each fire run as per the plans.
 - Radio Detector - With the receiver wired in the cabinet and using an external radio transmitter, test each fire run as per the plans.
 - Hard Wired - Attach a temporary push button as per the plans and test each fire run as per the plans.
 - 2. Railroad Pre-emption
 - Simulate closing the calling circuit, either manually or electronically to call up the Railroad pre-emption, then check and verify that the sequencing, timings and intervals are as per the plans.
- K. Check exhaust fan controls by applying heat from a 100 watt lamp on an extension cord to the thermostat.
- L. Check heat lamp controls by cooling the thermostat.
- M. Check conflict monitor by testing for any conflicting Greens or Yellows by the use of a jumper wire attached to a displayed Green or Yellow and to the other non-parent Greens or Yellows to ascertain that conflicting colors are not present.

When all of the above procedures have been completed, the performing technician shall document the results on the approved form as provided by the Bureau.

2.5.2 Controller cabinet. Controller, timing and flashing mechanisms, circuitry, and other components shall be enclosed within a weather tight 1/8 inch (3 mm) thick aluminum “p” type cabinet

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with 2 shelves, side and back panels, a main door and a switch compartment door on a 12 inch (300 mm) aluminum extension base. All exterior seams shall be continuously welded. Cabinets shall be similar to Gammatronix and TCT 8-phase cabinets.

2.5.2.1 Two adjustable “c” mounting channels to allow for positioning of panels and shelves shall be installed on both side walls and back of the cabinet.

2.5.2.2 The two adjustable equipment shelves shall span the entire width of the cabinet. No part of the back panel shall extend above the equipment shelves.

2.5.2.3 The cabinet door shall be a minimum of 80% of the front surface area and shall be hinged on the right side with a continuous hinge. The cabinet door frame shall be flanged on all four sides with a light/alarm switch bracket located in the upper right hand corner. The latching mechanism shall be a 3-point draw roller type made of steel with a center catch. The operating handle shall have provisions for padlocking in the closed position. The main lock shall be a Corbin 1548-1 and furnished with two number 2 keys. The door shall have a gasket that forms a weather tight seal between the door and the cabinet. The lower portion of the door shall be vented with louvers on the exterior to provide 100 cfm (50 L/s) of air flow. A filter held firmly in place by side and bottom brackets shall cover the louver vents on the doors interior. A door restraint shall be furnished to prevent door movement during windy conditions.

2.5.2.4 The exterior of the cabinet shall be painted a forest green. The interior surface of the cabinet and door, including shelves shall be painted with an appliance white alkyd baked enamel paint.

2.5.2.5 A switch compartment with removable back plate shall be furnished on the main door. The compartment door opening shall be flanged on all sides. The compartment door shall be hinged on the right side with a continuous hinge and have a gasket that forms a weather tight seal when closed. A compartment door lock Corbin RS57565 with key hole cover and two keys shall be furnished. The switch compartment shall contain:

- a. Signal automatic/flash switch.
- b. Signal on/off switch.
- c. Signal automatic/manual switch.
- d. A manual advanced police button.

2.5.2.6 A ventilation fan powered by a 115 volt single phase motor and rated at an air flow of 100 cfm (50 L/s) shall be installed at the top of the cabinet. The screened exhaust vent shall be vented between the top of the cabinet and the door. The ventilation fan shall be controlled by means of a thermostat with a range of 70 to 160 °F (21 to 71 °C) with overload protection and noise suppressor.

2.5.2.7 A cabinet heat lamp of 100/150 watts shall be installed. The heat lamp shall be controlled by a thermostat located on the left side of the cabinet with a range from 0 to 50 °F (-18 to 10 °C).

2.5.2.8 The cabinet power panel shall be installed on the right side of the cabinet 8 inch (200 mm) up from the mounting flange. It shall have a 30 amp and a 15 amp circuit breaker. The 15 amp breaker shall service the GFI duplex outlet, a switched light outlet, the heat lamp and the ventilation fan. The 30 amp breaker shall service all other items. The GFI outlet shall be mounted on the power panel. The switched light outlet shall be mounted on the upper right side. An AC line filter and ISTROL series line filter for controller and conflict monitor and lightning/surge suppressor shall be installed on the power panel.

2.5.2.9 Cabinet trouble light shall be a stainless steel, flex shaft type, 18 inch (460 mm) in length with on and off switch. Trouble light shall be mounted on the right-inside of the cabinet.

2.5.2.10 The cabinet shall be furnished with a plastic print holder and 3 sets of cabinet prints showing all wiring. Print holder shall be mounted on the inside of the door.

2.5.2.11 Cabinets shall be furnished with 10 self tuning loop detector amplifiers. Loop detector amplifiers shall have as a minimum 4 operating frequencies, 15 levels of sensitivity, a sensitivity boost for small and high vehicles, internal loop diagnostics and LED fault indicators identifying and differentiating between an open or shorted loop, or a sudden 25 percent change in inductance and a RS232 serial port.

2.5.2.12 Vehicle Detection Panel. The vehicle detection panel shall be installed on the left side of the cabinet, the bottom edge shall be 10 inch (250 mm) from the mounting flange. Loop field terminals shall be protected from inductive transient surges by 150 V, 10 A Metal Oxide Varistor. All detector terminals shall be identified by number and shall correspond with the cabinet print. All detector harnesses shall be labeled as to phase and shall be a minimum of 6 ft (1.8 m) in length and neatly dressed.

Detector panel for Type M cabinet shall be supplied with 6 harnesses wired as follows:

- a. Detector harness 1 - Phase 1
- b. Detector harness 2 - Phase 2
- c. Detector harness 3 - Phase 2
- d. Detector harness 4 - Phase 3
- e. Detector harness 5 - Phase 3
- f. Detector harness 6 - Phase 4

Detector panel for Type P cabinets shall be supplied with 10 harnesses wired as follows:

- a. Detector harness 1 - Phase 1
- b. Detector harness 2 - Phase 2
- c. Detector harness 3 - Phase 2
- d. Detector harness 4 - Phase 3
- e. Detector harness 5 - Phase 4
- f. Detector harness 6 - Phase 5
- g. Detector harness 7 - Phase 6
- h. Detector harness 8 - Phase 6
- i. Detector harness 9 - Phase 7
- j. Detector harness 10 - Phase 8

2.5.2.13 Load Switch. The cabinet shall be supplied with 12 solid state cube type load switches with a 10 A rating meeting the requirements of NEMA TS-1. Load switches shall be provided with LED indicators on both input and output sides to indicate the state of the circuit on the load switch.

2.5.2.13.1 The back panel shall have 12 load switch sockets completely wired including conflict monitor. All terminals shall be labeled for identification corresponding to the back panel print. Load switch sockets shall be wired as shown below.

<u>Load Switch Socket</u>	<u>Phase Assignment</u>
1	Phase 1
2	Phase 2
3	Phase 3

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4	Phase 4
5	Phase 5
6	Phase 6
7	Phase 7
8	Phase 8
9	Pedestrian
10	Overlap A
11	Overlap B
12	Overlap C

2.5.2.14 Flash Transfer Relays. The cabinet shall be supplied with 6 flash transfer relays that meet the requirements NEMA Standard TS-1.

2.5.2.14.1 The back panel shall have 6 flash transfer relay sockets completely wired and assigned as shown below:

<u>Relay</u>	<u>Assignment</u>
Flash Relay 1	Load Switch 1 and 2
Flash Relay 2	Load Switch 3 and 4
Flash Relay 3	Load Switch 5 and 6
Flash Relay 4	Load Switch 7 and 8
Flash Relay 5	Load Switch 9 and 10
Flash Relay 6	Load Switch 11 and 12

2.5.2.15 Signal Flasher. The cabinet shall be supplied with one (1) NEMA Type 2 solid state cube type signal flasher mounted on the back panel.

2.5.2.16 Pedestrian/Vehicle Detector Test Panel. A pedestrian/vehicle detector test panel shall be surface mounted on the interior side of the cabinet door. A push type test button shall be labeled and furnished for each phase. Pushing the button shall cause a detector call to be placed on the controller for as long as the button is held. Test panel wires shall be enclosed in a cable harness.

2.5.2.17 Controller On/Off Switch. A controller on/off switch shall be surface mounted on the interior side of the cabinet door or in the upper right hand side of the cabinet.

2.5.2.18 Conflict Monitor. A 12-channel conflict monitor with liquid crystal display meeting current NEMA Standard TS-1 requirements shall be provided in the cabinet. The liquid crystal display shall have the capability of showing all 4 possible signals per channel. The monitor shall retain complete information on the last 9 events including which channels were active, the date and the time. The assignment of conflicting channels shall be means of a standard NEMA program card. The monitor shall be wired to detect absence of voltage on all channels. The monitor shall have as RS232 serial port for down loading. Monitor channels shall be assigned as shown below:

Channel 1	Phase 1
Channel 2	Phase 2
Channel 3	Phase 3
Channel 4	Phase 4
Channel 5	Phase 5
Channel 6	Phase 6
Channel 7	Phase 7
Channel 8	Phase 8
Channel 9	Pedestrian

Channel 10	Overlap A
Channel 11	Overlap B
Channel 12	Overlap C

2.5.2.18.1 Monitor Interlock Relay. The cabinet shall be wired to detect the presence of the conflict monitor. Disconnection of the conflict monitor from its harness shall cause the intersection to go into flash.

2.5.2.19 Fire Pre-emption. Fire pre-emption shall be activated by “Opticom” equipment with optical detectors. Fire pre-emption shall clear the existing phase through a normal clearance followed by the fire phase as shown on the plans for the minimum time specified. The fire phase shall give a green in the called direction. The confirmation light and siren (if used) shall be activated only during the fire pre-emption phase, after the call phase is satisfied. Upon release of the fire pre-emption, the controller shall provide a green to the main street.

2.5.2.19.1 The engineering, design, and integration of the fire pre-emption shall be by the manufacturer of the equipment, in cooperation with the supplier of the signal controller equipment.

2.5.2.19.2 The confirmation light shall be operated by a solid state load switch cube surface mounted on a panel located on the left side of the cabinet. No back panel load switches shall be used for the confirmation light.

2.5.2.19.3 Confirmation light shall be a self-contained 120 volt AC industrial strobe light beacon with a weather-resistant, fully enclosed, rugged, cast aluminum base and lexan red optic lens.

2.5.2.19.4 Optical detector locations shall be verified by the Engineer to assure optimum reception. Optical detector cable shall run unspliced from the optical detector head to the controller cabinet.

2.5.3 Contacts. All contacts used in connection with interval indications shall be of pure coin silver or equivalent, and shall be capable of breaking and carrying 10 A at 125 V alternating current. The contacts shall be readily accessible and capable of being replaced in the timer without the use of any tools other than pliers and screw driver.

2.5.4 Flashers. Intersection beacon flashers shall be housed in an approved cabinet containing: 25 A NEMA cube-type flasher, 10 A circuit breaker, and disconnect switch. All components shall be completely wired and mounted within the cabinet. Painting shall be in accordance with 3.12.

2.5.5 Pedestals. Meter pedestal shall be as indicated on the plans.

2.5.6 Radio and television interference. Electrical equipment shall be prevented from interfering with radio and television reception.

2.6 Cable and Wire.

2.6.1 General. Cable shall be plastic covered cable meeting the applicable requirements of the International Municipal Signal Association (IMSA) specifications. The conductor color coding shall not be by means of printed code. Actual color coding shall be used.

2.6.2 The minimum size wire for the circuits shall be as follows:

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	Service	A.W.G.#
(a)	To Controller	8 Stranded
(b)	Controller to Pole or Pedestal	12 Stranded
(c)	Pole or Pedestal to Receptacles	14 Stranded
(d)	Controller to Push Buttons	14 Stranded
(e)	Detector Loop Lead-In	16 IMSA Spec. 50-2
(f)	Detector Loop Wire	14 IMSA Spec. 51-5
(g)	Equipment Grounding Conductor	8 Stranded

2.6.3 Detector loop lead-in cable shall be shielded, single pair, stranded conductors with a drain wire enclosed in polyethylene jacket conforming to the requirements of IMSA 50-2. The use of cables carrying more than one pair of conductors is prohibited.

2.6.3.1 Each lead-in cable shall be marked with plastic tape corresponding to the following color code to identify which phase it pertains to at the splice(s) in both the pull box(es) and in the cabinet.

PHASE COLOR CODE

Phase 1	1 Blue
Phase 2	1 Green
Phase 3	1 Yellow
Phase 4	1 Red
Phase 5	2 Blue
Phase 6	2 Green
Phase 7	2 Yellow
Phase 8	2 Red

2.7 Conduit. Traffic signal conduit, pull boxes, frames, and covers shall conform to 614.2.

2.7.1 Conduit for all lines, except the service, shall be 3 inch (75 mm) in diameter. Service conduit shall be rigid steel conduit 1-1/4 inch (32 mm) inside diameter.

2.8 Painting. Prior to erection and assembly, if not manufactured of polycarbonate material, the entire traffic or pedestrian signal housing and visors shall be painted with an approved zinc-rich primer 708-NH 1.50 and a finish enamel coat of federal yellow 708-NH 3.72. The doorface and inside visor shall be black 708-NH 3.75.

2.9 Backfill for foundations, unless otherwise ordered, shall be Granular Backfill-Gravel conforming to the requirements of 209.2.1.2.

Construction Requirements

3.1 All traffic signal and electrical installations shall comply with the requirements specified herein, local and utility codes, MUTCD, and the National Electrical Code (NEC).

3.1.1 A preconstruction meeting with the Contractor, signal subcontractor, Engineer and Bureau of Traffic representative shall be arranged not less than 3 days prior to the start of signal installation, to resolve any problems.

3.1.2 The signal subcontractor shall notify the NHDOT Bureau of Traffic, Signal Design Section no less than 3 days prior to the following:

- A. The date of beginning construction.

- B. The date of cutting in loops in pavement.
- C. The date of preliminary review of construction.
- D. The date of final inspection.

3.2 Each signal head mounted on a mast arm shall be installed with a 1/8 inch (3 mm) diameter aircraft cable, looped around the mast arm and mast arm bracket, as a safety device to prevent the signal head from falling. Cable ends shall be fastened by two opposing “U” clamps. When suspended by this cable, the top of the signal head shall be no more than 6 inch (150 mm) below the bottom of the mast arm.

3.3 Conduit lines. All conduit lines necessary shall be constructed for the proper operation of the signals and shall conform to 614.3.

3.3.1 All conduits terminating in the cabinet shall be sealed with duct sealant.

3.4 Concrete foundations with anchor bolts to secure the traffic signal structures, flasher or controller cabinets, and meter pedestals, shall be installed at the locations specified. When directed, the concrete foundation for the controller cabinet shall be raised to any height up to 18 inch (450 mm) above the surface. Chamfer strips shall be used on all signal controller cabinet foundations. Forms shall be inspected before concrete is placed.

3.4.1 The void created by the leveling nuts between the foundation and the base plate of the structure shall be filled with an approved non-shrink grout.

3.4.2 Prior to placing the controller cabinet on its foundation, silicone sealant shall be applied to the area of contact.

3.4.3 The Contractor shall use bolt pattern templates when setting mast-arm anchor bolts, signal pedestal bolts and controller cabinet mounting bolts. The templates shall remain in place for a minimum of 24 hours.

3.4.4 Wood poles shall have the butt end buried in the ground to a depth of 8 feet.

3.4.5 Wood poles with back-guy cable shall have the butt end of pole buried 8 feet into the ground. Poles shall be back-guyed using a 10-inch expanding anchor with 3/4 inch by 96-inch anchor rod. Thimble eyes of anchor rods shall extend 12 inches above ground. Cable used for back-guying shall be attached to the anchor rod by short bail automatic type grip and to the guy hook on the pole by a preformed type grip. Pole shall be drilled 14 inches from top and a 5/8 inch oval eyebolt installed with one square flat washer and square nut on the messenger side and one square washer, square nut and guy hook on the opposite side.

3.5 Inductive Loop Detectors.

3.5.1 Loop installation shall follow these specifications and the Loop Detail Sheet as to colors, connections, splicing kits, step procedures and materials used.

3.5.1.1 Curb entry. Nonmetallic conduit shall be utilized from the pull box to its intercept with the saw cut. The visible portion of the curbing shall not be cut for conduit installation. The chase from the saw cut to the splice box should extend no more than 1 ft (0.3 m) from the curb. Conduit shall be installed so that it directly receives the lead-in wire.

3.5.1.2 Saw cut. The saw cut shall be a clean, well defined 5/16 inch (8 mm) wide cut and done without damaging the adjacent pavement. The saw cut depth shall be at least 1-3/4 inch (45 mm) for asphalt and 1-1/4 in (32 mm) for concrete. The saw cuts shall be overlapped to provide full depth at all

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corners, and all slots requiring a right angle turn of wire shall be cut at a 45 degree diagonal angle. Prior to the installation of wire, the saw cuts shall be checked for the presence of ragged edges or protrusions, and cleaned and dried. Cutting dust, grit, oil, moisture, or other contaminants shall be removed.

3.5.1.3 Loop wire installation. All loop installations shall be made without damage to the wire or its insulation. All damaged wire shall be replaced. The loops shall be installed as per plans, and shall contain the required number of turns as shown or as recommended by the manufacturer.

3.5.1.3.1 The wire shall be laid in the slot so that there are no kinks or curls and no straining or stretching of the insulation. Loop wire shall be installed as far down in the slot as possible, using a blunt object similar to a wooden paint stirrer, to seat the loop wire, but in no case shall a screwdriver or other sharp tool be used for this purpose. The loop lead-in wires shall be twisted to provide a minimum of one turn per foot from the loop to the pull box.

3.5.1.3.2 A minimum of 3 ft (1.0 m) of slack shall be coiled and left in the pull box. Where the loop wire crosses cracks or joints in the pavement, plastic sleeving shall be used to insulate the wire, to a minimum of 4 inch (100 mm) on either side of the crack or joint.

3.5.1.4 Initial Testing. Prior to pouring sealant, the detector loop and loop lead-in cable shall be checked for continuity, inductance, resistance and integrity of the insulation. The tests shall be made in the presence of the Engineer and results shall be recorded on the as-built plans in the space provided. If the results of the measurements fall outside the specified range for one or more tests, the Contractor shall replace any portion or all of the system until proper readings are obtained.

3.5.1.4.1 The inductance of each detector loop lead-in cable system shall be measured at the controller cabinet with the drain wire connected to ground. The inductance of each detector loop lead-in in the system shall be between 175 to 500 μH .

3.5.1.4.2 The DC resistance of each detector loop lead-in cable shall be measured at the controller cabinet. The DC resistance shall be between 2 to 6 Ω .

3.5.1.4.3 The resistance of each conductor to ground in the detector loop lead-in cable shall be measured by leaving the other conductor free and the drain wire connected to ground. This resistance shall be a minimum of 10 $\text{M}\Omega$ under any weather and moisture conditions.

3.5.1.4.4 The resistance of the drain wire to ground in the detector loop lead-in cable shall be measured by leaving both conductors free and all other drain wires disconnected from ground. This resistance shall be a minimum of 10 $\text{M}\Omega$ under any weather and moisture conditions.

3.5.1.4.5 The integrity of the insulation shall be checked by applying a meg-ohm meter between each end of the detector loop lead-in and the nearest reliable electrical ground. In the event that no available ground exists, a suitable ground shall be established for the measurement. The meg-ohm meter reading shall be a minimum of 10 $\text{M}\Omega$ under all conditions.

3.5.1.5 Sealant. Saw cut sealant shall be an approved flexible embedding sealant as included on the Department's Qualified Products List maintained by the Bureau of Materials and Research used strictly in accordance with the manufacturer's instructions. The sealant shall be poured into the slot to half depth, checked for air bubbles or material pile up, then filled to the roadway level. Excess sealant shall be removed by means of a squeegee, and in any case, neither a trough nor a mound shall be formed. Sufficient time shall be allowed for the sealant to harden in accordance with manufacturer's instructions before allowing traffic access to the area.

3.5.1.6 Final testing. Repeat the test procedure specified in 3.5.1.4.

3.5.1.7 Detector feeder cable installation. The feeder cable and the loop lead-in wire shall be terminated in the pullbox and all connections shall be spliced, soldered, compounded and taped. The entire splice shall be encapsulated in a waterproof splice kit approved by the Engineer.

3.5.1.8 Record keeping. A record of any modifications to the original installation shall be made by the Contractor. The Contractor shall furnish the Engineer with 3 copies of the corrected or as-built plans including initial and final test results.

3.6 Service and Meter Box.

3.6.1 When required, the Contractor shall furnish and install a service riser on the pole selected by the power company in conformity with the plans, and shall also furnish the power company its choice of equipment above the switch or breaker. Wire sizes shall be as specified by either the plans or the power company. In case of discrepancy, the larger size shall be used.

3.6.2 A NEMA weatherproof disconnect switch and cabinet shall be furnished and installed at the location specified. The circuit breakers in this switch shall be 30 A.

3.6.3 The Contractor shall make all arrangements for the service connection and be responsible for all charges incurred thereby.

3.6.4 Under no conditions shall any equipment be installed on any utility pole unless specifically stated on the plans.

3.6.5 The Contractor shall notify the telephone company whenever a service connection is to be made on a jointly owned pole, providing the telephone company with the following information:

- (a) Intersection
- (b) Pole Number
- (c) Date and time of preliminary arrangement with electric power company.

3.6.6 In the case of underground services, the Contractor shall furnish and install all equipment as required by the power company, be responsible for all charges incurred thereby, and complete the work to the satisfaction of the power company. Meters shall not be installed in manholes.

3.6.7 The Contractor shall be responsible for all outstanding bills of the electric power company for preliminary work done by the power company during the construction of the road to facilitate the service connection of that particular installation. The Contractor shall also be responsible for all service charges until the signals are accepted for operational use by the Engineer.

3.7 Signal Cable and Wire Installation.

3.7.1 The Contractor shall furnish and install sufficient cable and wire to operate the system properly and at least 4 spare conductors in each cable run shall be provided.

3.7.2 No more than one cable shall be permitted in a conduit except to eliminate splices in pull boxes. When more than one cable is permitted, the area of combined cables shall not exceed 30 percent of the inside area of the conduit.

3.7.3 All pedestrian signals and push buttons shall be individually wired from the field to the cabinet terminals.

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3.7.4 Messenger cable shall run unspliced between poles and shall be installed with a 5 percent sag in the wire when measured from the point of attachment to the middle of span. The cable shall be attached to the pole eyebolt by a preformed type grip on one end and an automatic type grip on the opposite end. Messenger cable shall be grounded to the back-guy cable.

3.8 Signal bases, housings, and controllers shall be furnished and installed as required. All structures and housings shall be plumb after erection.

3.8.1 Multiple housings on a single post shall be grouped together using 1-1/2 inch (38 mm) galvanized pipe and 1-1/2 inch (38 mm) galvanized rail fittings. All attachments to the posts shall be made by means of adapters conforming to 2.2.2. The center of all housings shall be in the same horizontal plane.

3.9 Miscellaneous electrical equipment. All additional electrical fittings, service conduit, switches, fuses, traffic signal bulbs, and such other hardware as is necessary to properly and securely install the equipment shall be furnished. All electrical fittings shall be weatherproof.

3.10 Wiring and connections. All connections shall be spliced, soldered, compounded, and taped, using the following color code:

(a) Red Wire	Red, Main Street
(b) Orange Wire	Yellow, Main Street
(c) Green Wire	Green, Main Street
(d) Red with tracer	Red, Side Street
(e) Orange with tracer	Yellow, Side Street
(f) Green with tracer	Green, Side Street
(g) White	Neutral for all signals
(h) Blue	All steady burning arrows
(i) Blue with tracer	Intermittent arrows
(j) Remaining	Push buttons and spares

Note: The white wire shall be used for all neutral connections and shall be connected to the service ground.

3.10.1 No street lighting splices will be permitted in the mast-arm shaft. Splices for street lighting and lightning arrestors shall be located inside the nearest street light pull box.

3.11 Ground connections. All installations and equipment shall be bonded and grounded to the service ground rod in accordance with the requirements of the electric power company.

3.11.1 Each signal cable run shall be installed with one green plastic covered copper ground wire to which all equipment shall be bonded in accordance with standard practice. Each base and post, cabinet, and any other component that would be considered a part of the signal system shall be bonded to the ground wire. This ground wire shall be connected to the ground rod at the controller cabinet.

3.12 Painting. All paint shall conform to 708. The following colors of enamel shall be used:

(a) Controller Cabinet	Outside: Green (1); Inside: White (4)
(b) Housings	Yellow (3)
(c) Visors	Inside: Black (2); Outside: Yellow (3)
(d) Meter Box	Same color as its mounting.

(1) Green Enamel = 708-NH 3.74

- | | | |
|-----|-----------------------|---------------|
| (2) | Black Enamel | = 708-NH 3.75 |
| (3) | Federal Yellow Enamel | = 708-NH 3.72 |
| (4) | White Enamel | = 708-NH 3.73 |

After the signals have been completely installed, two coats of enamel shall be applied to all unpainted or scratched surfaces after the surface has been lightly sanded to remove gloss.

3.13 Operating sequences shall be as shown on the plans or ordered.

3.13.1 Operating sequences shall be verified by testing.

3.13.2 In cooperation with the Fire Department, the Contractor shall make trial runs to ascertain proper timing of the fire pre-emption system. The minimum time shall be approved by the Chief of the Fire Department or the Chief's representative.

3.14 Installation of signals and equipment. The signals and equipment shall be installed by competent workmen or the manufacturer's representative.

3.14.1 Prior to placing the signals in operation, the signal housing shall be hooded with approved non-transparent material or turned to clearly indicate that the signals are not in operation.

3.14.1.1 Signs mounted on the signals not applicable to construction conditions shall be covered as specified in 619.3.

3.14.2 All material including poles, foundations, fittings and cable shall be supplied and installed to make a complete operative installation.

3.14.3 Signs installed on signal arms shall be mounted with "Astro Bracs" at a right angle to the roadway.

3.15 Operation. The Contractor shall commence the operation of the signal system only when permitted by the Engineer.

3.15.1 The Contractor shall provide a qualified technician to thoroughly review and confirm that the system is satisfactory and operational as designed. Prior to the final inspection, the Contractor shall have a review with the NHDOT Bureau of Traffic representative and local officials (including Fire Department technician) to review and comment upon the system.

3.16 Warranty. Upon completion of the project, the Contractor shall forward to the Commissioner all warranties to the purchaser that the equipment which has been installed hereunder shall be free from defects in materials, workmanship, and title, and shall be of the kind and quality designated or described in the contract. The foregoing warranty supersedes all other warranties whether written, oral, or implied. If it appears within 6 months from the date of Acceptance of the work that the equipment installed hereunder does not meet the warranties specified above, the Contractor shall promptly correct any defect or nonconformance with the specifications. This warranty does not relieve the Contractor of the requirement of 106.04.

Method of Measurement

4.1 Traffic signals and flashing beacons will be measured as a unit. Where more than one unit is specified in the contract, separate item numbers will appear for each separate and complete unit.

SECTION 616

Basis of Payment

5.1 The accepted quantity of traffic signals or flashing beacons will be paid for at the contract lump sum price complete in place.

5.2 When an item of conduit appears in the contract, conduit for traffic signals will be paid for under 614.

5.2.1 When no item for conduit appears in the contract, any conduit required will be subsidiary.

5.3 Materials required under 3.9 shall be subsidiary.

Pay items and units:

616.1__	Traffic Signals	Unit
616.2__	Flashing Beacons	Unit
616.4__	Relocating Traffic Signals	Unit
616.5__	Concrete Bases	Unit
616.6__	Relocating Flashing Beacons	Unit

SECTION 618 -- UNIFORMED OFFICERS AND FLAGGERS

Description

1.1 This work shall consist of furnishing qualified uniformed officers, with or without vehicles, or flaggers as required to direct traffic through or around the work or as ordered.

1.1.1 The Contractor may perform this item with his own forces, uniformed officers, a commercial security firm or subcontractors. Commercial security firms and subcontractors shall comply fully with Section 108.01, including Equal Employment Opportunity, Payroll and Minimum Wages as applicable.

Equipment

2.1 Vehicles for use with uniformed officers shall be official police vehicles with associated equipment including roof mounted blue flashing lights that are visible to oncoming traffic and appropriate police markings.

2.2 Traffic paddles and flagger equipment shall conform to those described in the MUTCD or New Hampshire Traffic Control Handbook as appropriate.

2.3 Two-way radios for uniformed officers and flaggers shall be dependable, providing clear communication at all times between radio operators.

Construction Requirements

3.1 Uniformed officers employed by the Contractor shall have had formal traffic control training, as provided by the Police Standards and Training Council.

3.2 Contractors or subcontractors supplying flaggers shall have an employee(s) designated to train flag personnel. Designated trainers shall have taken a flagging course as described in 3.2.1 at least every three years.

3.2.1 A flagging course taken by employees designated to train shall consist of a minimum of 3 hours of training providing the following general information:

- A. Federal and State requirements as specified in the MUTCD and NHDOT Flagger Handbook.
- B. The need for consistent, current and understandable instruction from flaggers.
- C. An understanding of the MUTCD Part VI requirements.
- D. The awareness of types of motorists and vehicles (commuters, tourists, passenger, trucks, emergency, oversized, etc.).
- E. The safety of the work crew, motorists and the flagger.

And the following specific items:

- A. Federal and State requirements as specified in the MUTCD and NHDOT Traffic Control Handbook.
- B. The qualities of a flagger which include:
 - 1. A sense of responsibility for the safety of the public and workers.
 - 2. Training in safe traffic control practices.
 - 3. Being in good physical condition, including sight and hearing.
 - 4. Mental alertness and the ability to react in an emergency.
 - 5. A courteous but firm manner.
- C. The flagger's attire which is:
 - 1. High visibility clothing for day and/or night.
 - 2. Distinctive from the other workers.
- D. The tools necessary to perform flagging operations and their correct use.
 - 1. Equipment which includes, but is not limited to, paddles, flags, flashlights for night, and etc.
 - 2. Correct and appropriate hand signals.
- E. Work station safety which includes, but is not limited to, advance warning signs placement, flagger station location and flagger position.
- F. The additional requirements and differences of night flagging operations.
- G. Coordination with other flaggers, work crew, uniformed officers and traffic signals.

3.2.1.1 Designated trainers shall pass a written examination containing thirty or more questions reviewing the principles of flagging. A passing score shall be a minimum of 70 percent.

3.2.1.2 Upon successful completion of the flagging course and passing the written examination the attendee shall receive a flagger handbook and a completion certificate. The completion certificate shall contain the name of the course provider, the date of the course, and the name of the designated trainer who successfully completed the course.

3.2.2 All flagging personnel shall be trained by a designated trainer at least every three years. The course shall cover the topics outlined under 3.2.1. Flaggers may elect to take a designated trainer course to meet the training requirements in this section.

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3.3 Uniformed officers and flaggers shall be clothed in a suitable and characteristic manner that will readily distinguish them from all other employees.

3.3.1 Uniformed officers shall be attired with regulation duty uniforms, headgear and reflective vests with or without white stripes, and shall wear an exposed badge.

3.3.2 Flaggers shall be attired with blaze orange caps and vests with or without white stripes. Inappropriate attire shall not be allowed.

3.4 Authorities providing uniformed officers or subcontractors supplying flaggers will designate a person as the responsible party to coordinate the traffic control procedures with both the general superintendent and the Engineer. This person will be responsible to collect and report the time of actual traffic control to all interested parties.

3.5 Personnel Requirements and Authority.

3.5.1 Uniformed officers and flaggers shall possess the following qualifications: at least average intelligence and alertness, good sight and hearing, courteous but firm manner, neat and presentable appearance, pleasing personality, and a sense of responsibility. They shall have been given specific instructions as to their duties and responsibilities, both to the public and to their fellow workers on the job. They shall have authority to direct the movement of construction vehicles as well as vehicles of the traveling public, and shall do all that is reasonable to expedite that movement.

3.5.2 Uniformed officers shall have police powers granted by the authorities having legal jurisdiction in the work area.

3.5.3 Uniformed personnel from commercial security firms shall be regarded as flaggers.

3.5.4 For night operations, high-intensity reflectorized clothing and the use of lighting shall be required, as stated in the MUTCD and the New Hampshire Traffic Control Handbook.

3.6 Consistent with the Department's policy on Use of Median Crossovers on Construction Projects, uniformed officers with vehicles shall be provided by the Contractor during the hours of crossover use as directed by the Engineer.

3.7 When more than one Uniformed Officer or Flagger is required for traffic control, effective communication shall be maintained between stations. If effective communication can not be maintained by voice or hand signals, two-way radios shall be used. Necessary safety precautions shall be taken when two-way radios are used in the vicinity of blasting operations.

Method of Measurement

4.1 Uniformed officers, uniformed officers with vehicles, and flaggers will be measured by the actual numbers of hours authorized, as determined by the Engineer.

4.1.1 The Contractor's schedule for utilizing uniformed officers, uniformed officers with vehicles, and flaggers shall be agreed upon cooperatively with the Engineer. The Contractor may furnish additional traffic control personnel at his expense but only those agreed upon by the Engineer will be measured for payment.

4.1.2 In no case shall uniformed officers or flaggers be paid less than the flagger rate as specified in the contract.

SECTION 618

4.1.3 Uniformed officers with vehicles provided by the Contractor in accordance with 3.6 will not be measured for payment.

Basis of Payment

5.1 The hours authorized for uniformed officers or uniformed officers with vehicles will be paid for at the invoice value plus a 5 percent mark-up.

5.1.1 The invoice may include salary, fringe benefits and overtime for the rank of officer appropriate to perform the required duties, and a reasonable vehicle use charge for uniformed officers with vehicle.

5.1.2 The Bidder's attention is called to the dollar amount inserted in the proposal under these items, which dollar amount is the amount the State has set for uniformed officers, or uniformed officers with vehicle. This amount must not be altered by the Bidder on the proposal, and must be included to obtain the grand total of the bid.

5.1.3 Payment of the amount set in the proposal will not be on a lump sum basis, but only the dollar value as authorized will be paid.

5.2 The hours authorized for flaggers will be paid for at the contract unit price per hour.

Pay items and units:

618.6	Uniformed Officers	Dollar
618.61	Uniformed Officers with Vehicle	Dollar
618.7	Flaggers	Hour

SECTION 619 -- MAINTENANCE OF TRAFFIC

Description

1.1 This work shall consist of providing and maintaining safe and passable traffic accommodations for public travel; preventing dust nuisance; and furnishing, erecting and maintaining necessary traffic signs, barricades, lights, signals, delineators, concrete barriers, pavement markings, and other traffic control warning devices and shall include pilot car operations and other means of guidance of traffic through the work zone. The Contractor shall be responsible for this work and shall perform it in accordance with the current MUTCD, Work Zone Traffic Control Standard Plans, the approved Traffic Control Plan (TCP) and these specifications.

1.2 A list showing the permanent construction signs and warning devices will appear in the Contract plans. The Contractor shall determine the appropriate operational construction signs and warning devices based on the needs of the Contractors daily operation.

Materials

2.1 Traffic control devices shall conform to the MUTCD and as specified herein. New devices covered by testing and evaluation criteria in the National Cooperative Highway Research Program (NCHRP) Report 350, titled "Recommended Procedures for the Safety Performance Evaluation of

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Highway Features,” shall also conform to that criteria by the extended compliance dates implemented by the AASHTO-FHWA Agreement (350 Agreement) dated July 1, 1998. A summary of the work zone traffic control devices categories for new devices to conform with NCHRP Report 350 is provided in the Special Attention entitled “Traffic Control Devices Compliance with NCHRP Report 350.”

2.1.1 Base material for permanent construction signs shall be weather-proof, rigid substrate specifically manufactured for highway signing and meet the retroreflective sheeting application requirements of the sheeting manufacturer.

2.1.2 Base material for operational construction signs shall conform to 2.1.1, except that flexible base material will be allowed.

2.1.3 Sign blanks shall be prepared in accordance with current practice as recommended by the sheeting manufacturer.

2.1.4 Retroreflective sheeting for traffic control devices, including permanent and operational construction signing, shall conform to AASHTO M 268 (ASTM D 4956), Type III Retroreflective Sheeting as a minimum or Type VI for flexible base material.

2.1.4.1 Category I Traffic Control devices (plastic or rubber cones, tubular markers, flexible delineators, and plastic drums, etc.) shall have Type III sheeting.

2.1.4.2 Only ROAD WORK (W20-1) signs and Length of Work (G20-1) signs shall be a fluorescent orange color in accordance with 718.

2.1.5 Sign text shall consist of the letters, digits and symbols either applied by stick-on, or silk screen, to conform with the dimensions and designs indicated in the Contract, NHDOT Construction Sign Standards, MUTCD or FHWA Standard Highway Signs. The materials and methods shall be in accordance with standard commercial processes.

2.1.6 Supports and posts shall conform to the current AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signs”.

2.1.7 Portable changeable message sign (PCM) shall be capable of up to three lines of display with eight characters per line. Characters shall be a minimum of 18 inches (450 mm) high.

2.1.8 Trailer mounted speed limit signs shall be self-contained units, including sign assembly, flashing lights and power supply specifically constructed to operate as a trailer-mounted sign.

2.1.8.1 Sign assembly shall be as shown in the NHDOT Construction Sign Standards.

2.1.8.2 Each unit shall be equipped with two mono-directional flashing lights with amber lenses and reflectors which are visible through a range of 120 degrees when viewed facing the sign. The lights, either strobe, halogen, or incandescent lamps, shall be visible for a minimum distance of one mile under daylight conditions and shall have a minimum flash rate of 40 flashes per minute. An "ON" indicator light shall be mounted on the back of the signs which is visible for at least 500 feet (150 meters) to provide confirmation that the flashing lights are operating.

2.1.8.3 Power supply shall be either full battery power with solar panel charging (capable of maintaining a charged battery level) and 135 ampere, 12 volt deep cycle batteries, or diesel powered generator with a fuel capacity sufficient for 10 hours of continuous operation.

2.1.9 The contractor shall provide a Certificate of Compliance stating that traffic control devices being provided meet the testing and evaluation criteria of NCHRP Report 350 as implemented by the 350 Agreement.

2.1.10 All category I, II, and III project work zone traffic control devices in use, except portable concrete barrier that transfers tension and moment from segment to segment, shall conform to the testing and evaluation criteria of NCHRP Report 350. Devices not conforming to the criteria shall be replaced with conforming devices at no expense to the Department.

2.2 Calcium Chloride shall conform to AASHTO M 144, Type S, Grade 3.

Construction Requirements

3.1 Maintenance of Traffic.

3.1.1 Traffic control devices shall be properly placed and in operation before starting construction. When work of a progressive nature is involved, such as resurfacing, the appropriate traffic control devices shall be periodically repositioned in the advanced warning area.

3.1.2 Whenever the highway is open to public traffic through any part of the project, the Contractor shall provide and maintain sufficient surface for at least one lane of traffic, and two lanes whenever possible. Control of one lane traffic will be required at all times.

3.1.2.1 The Contractor shall notify the Engineer at least two weeks prior to beginning work that involves any major disruption of traffic.

3.1.3 Traffic Control devices either existing or supplied by the Department, shall be maintained at appropriate locations for the use of the traveling public during the construction period. Signs which are not applicable to construction conditions shall be covered completely with plywood, removed or relocated as necessary. Signs that are removed or relocated shall be retained and re-erected by the Contractor. The Contractor shall notify the Bureau of Traffic when any regulatory sign is removed or relocated.

3.1.3.1 All existing speed limit signs which conflict with the construction zone trailer mounted speed limit signs shall be covered completely as specified in 3.1.3 during the operation of the flashing lights. These signs shall be immediately uncovered when the use of the flashing lights is discontinued.

3.1.3.2 Devices damaged due to improper handling and storage shall be replaced with new devices.

3.1.4 Dust control shall be performed in an approved manner, generally by the use of water and shall be continued whenever necessary, even though all other work on the project is suspended.

3.1.4.1 The Engineer will determine when the use of Calcium Chloride is warranted to control dust nuisance. It shall be uniformly applied at a rate sufficient to control dust.

3.1.5 The Contractor may be required to delay or suspend work, as directed, that interferes with traffic during commuting hours, periods of inclement weather, or periods of high traffic volumes which result in excessive backup or create unsafe traffic operations.

3.1.6 For the protection of traffic, equip all vehicles used on the project with amber flashing lights or rotating lights visible from 360 degrees around the vehicle. The flashing light system shall be in continuous operation while the vehicle is on any part of the traveled lanes, shoulders or ramps within the construction zone.

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3.1.7 Blank.

3.1.8 Before any suspension of the work, including end of work day, the Contractor shall make passable and shall open to traffic such portions of the project and temporary roadways or portions thereof as may be agreed upon between the Contractor and the Engineer.

3.1.8.1 Pavement authorized for removal for trenching purposes within the traveled way shall be replaced with temporary bituminous material (cold patch or reclaimed asphalt pavement) before the roadway is open to traffic and shall be replaced with applicable hot bituminous pavement conforming to Division 400 within 72 hours of completed backfill operations.

3.1.9 When the work required as outlined in section 104.07 and 619.3.1.9.1 is completed by the Contractor, the Department will assume the winter maintenance of the roadway during the period of winter suspension without cost to the Contractor.

3.1.9.1 The Contractor shall either remove or relocate all portable concrete barrier to a minimum offset of 6 feet (1.8 meters) (10 feet/ 3 meters desirable) from the traveled way during the winter maintenance season. If the Department's traffic control plan and/or phase construction plan does not allow for this minimum offset and the snow built up in front of the barrier does not provide safe and passable accommodations to vehicular traffic, the snow accumulated in front of the portable concrete barrier shall be removed by the Contractor. The Contractor shall notify Highway Maintenance prior to performing this work.

3.1.10 When work is resumed after any suspension, the Contractor shall replace or renew any work or materials lost or damaged because of such temporary use of the project.

3.1.11 If the Engineer determines that maintenance of traffic and provisions for safe traffic control are not being provided or maintained by the Contractor, the Department may assume this responsibility and deduct the cost from moneys due the Contractor.

3.1.12 Any work performed by the Department, either when construction operations are taking place or during periods of suspension, will not invalidate the provisions of the contract.

3.2 Traffic Control Devices.

3.2.1 All traffic control devices supplied to the project shall be acceptable in accordance with the "Quality Standards for Work Zone Traffic Control Devices" as published by the American Traffic Safety Services Association (ATSSA) and the retroreflectivity shall be a minimum of 90 percent of new material.

3.2.1.1 At anytime during the life of the contract, including any suspension, any traffic control device that is in an unacceptable condition as described in the "Quality Standards for Work Zone Traffic Control Devices" or has a retroreflectivity of less than 70 percent of new material shall be replaced.

3.2.2 Construction signs shall be erected at the locations indicated on the plans or as approved. The posts shall be plumb. The signs shall be installed with the text horizontal.

3.2.3 Traffic control devices shall be erected wherever necessary for the protection of public travel.

3.2.3.1 Trailer mounted speed limit signs shall be used only during the Contractor's actual work hours, unless specifically authorized by the Engineer. Prior to the initial use of the speed limit signs, the Contractor shall submit, for approval, his schedule for use including the time of proposed speed limit reductions. This schedule shall be submitted sufficiently in advance of the proposed initial use to allow

the Engineer a minimum of 2 weeks to contact the District Maintenance Engineer and review the proposed locations of the speed limit signs and authorize their use.

3.2.3.1.1 The Engineer will record the actual time and location of the signs on a daily basis when the speed limit signs are in use.

3.2.3.2 Trailer mounted speed limit signs shall be located, one on each shoulder, 2,000 feet (610 meters) in advance of the project limits for mainline traffic. A sign shall also be located on the right shoulder 1,500 feet (457 meters) beyond the end of ramp acceleration lanes within the project. Placement of additional "REMINDER" signs may be ordered by the Engineer.

3.2.4 Operational signs and channelizing devices shall only be set up when weather conditions will allow adequate visibility.

3.2.5 Lighting devices shall be provided as required or ordered. The type and number of lighting devices shall conform to the plans and the MUTCD.

3.2.6 Keep all roadway areas that are open to traffic as clear as possible at all times. No materials or Contractor's plant and equipment shall be stored on any roadway areas or within the clear zone of the traveled way as specified in the TCP unless protected by portable barrier and specifically approved. Deliver materials to installation areas as needed to provide a continuous installation.

3.2.6.1 Remove all equipment and construction vehicles from the traveled way and within the clear zone of the traveled way as specified in the TCP during non-work hours unless protected by portable barrier and specifically approved.

3.2.6.2 Park worker's private vehicles close together in a group outside the clear zone of the traveled way as specified in the TCP unless protected by portable barrier and specifically approved.

3.2.6.3 Traffic control devices, including arrow panels, portable changeable message signs and trailer mounted speed limit signs shall be removed outside the clear zone of the traveled way as specified in the Traffic Control Plan when not in use unless protected by portable barrier or equivalent and specifically approved.

3.2.6.4 Trailer mounted traffic control devices, such as arrow panels, portable changeable message signs and trailer mounted speed limit signs shall be delineated with retroreflective temporary traffic control devices while in use. The trailers shall also be delineated by affixing a retroreflective material to them.

3.2.7 Do not conduct any operation (including loading and unloading vehicles) on or near the traveled way without first setting up the proper lane closure and traffic control devices.

3.2.8 All traffic control devices furnished by the Contractor shall remain the property of the Contractor unless otherwise specified and be removed at the completion of the project or when no longer required.

3.3 Pavement Marking.

3.3.1 Pavement markings shall be used in combination with appropriate traffic control devices to clearly define the required vehicle paths in accordance with the MUTCD. The intended vehicle path shall be clearly defined by pavement markings or channelizing devices or both at the end of the work period.

SECTION 619

3.3.1.1 At the end of each day's paving operation on a traveled roadway, pavement markings for centerlines and lanelines shall be applied in accordance with the MUTCD and the contract requirements. Temporary pavement markings may be used according to the NHDOT Work Zone Traffic Control Standard Plans and MUTCD, after which pavement marking that meet full MUTCD Standards shall be in place. All Temporary pavement markings shall remain in place while in service and if dislodged or rendered ineffective the temporary markings shall be replaced.

3.3.1.2 Temporary raised pavement markings may be used according to the MUTCD or as amended by the Work Zone Traffic Control Standard Plans, in the same color as specified for the markings and installed according to the manufacturers recommendations. Temporary raised pavement markers shall not be used to supplement or substitute for edge lines. Temporary raised pavement markers shall be a product listed on the Qualified Products List under the 619 items.

3.3.2 The application of pavement markings and/or removal of existing markings may not be required during daytime construction operations when traffic is controlled by flaggers or uniformed officers and channelizing devices are in place.

3.3.3 In the event that pavement markings are to be applied by the Department, the Contractor shall provide a clean surface and vehicle path free of obstructions.

3.3.4 Pavement markings that are no longer applicable shall be obliterated immediately preceding or following the change in lane usage. Such change in lane usage shall not be implemented until sufficient time, equipment, materials, and personnel are available to completely obliterate the markings.

3.3.5 Removable pavement marking tape shall be removed prior to placing subsequent pavement courses but not until immediately prior to beginning paving operations.

Method of Measurement

4.1 Maintenance of traffic will be measured as a unit.

4.2 Portable changeable message sign and trailer mounted speed limit sign will be measured as a unit. A unit shall consist of the sign as described, the trailer, fuel and all necessary moves as approved.

4.2.1 Portable changeable message sign (unit/week) and trailer mounted speed sign will be measured as a unit week. A week shall consist of seven consecutive days beginning when the item is first used on the project. The number of units required each week will be specified in the Traffic Control Plan or as approved.

4.3 The temporary bituminous material required in 3.1.8.1 will not be measured for payment.

Basis of Payment

5.1 Maintenance of traffic will be paid for at the contract lump sum price. Payment will be made periodically based on the anticipated construction period.

5.1.1 When the project conditions warrant illumination and such work is not shown on the plans or in the Special Provisions, the cost of furnishing, installing, maintaining (including power) and dismantling the necessary lighting will be paid for as provided in 109.04.

5.1.2 Replacements of any traffic control device required by 3.1.3 or 3.2.1 will be at the Contractor's expense.

5.1.3 The material cost of calcium chloride will be paid for as provided in 109.04. The labor and equipment necessary for material application will be subsidiary.

5.1.4 The material cost of permanent construction signs ordered but not included in the listing on the Contract plans will be paid for as provided in 109.04. The labor and equipment cost for installation will be paid for as provided in 109.04.

5.1.5 When no provision for Maintenance of Traffic is included in the contract, this work will be subsidiary.

Unless otherwise provided for in the Contract, the material cost and placement of temporary bituminous pavement for trench patching will be paid as specified in 403 under Item 403.99 temporary bituminous pavement. When Item 403.99 is not included in the contract, payment will be made at 1.5 times the cost of machine method specified under section 403.

5.1.6.1 Temporary bituminous material required in 3.1.8.1 is subsidiary to 619.

5.1.7 Unless otherwise provided for in the Contract, the material cost and placement of permanent hot bituminous pavement for trench patching will be paid as specified in 403 under hand method. When hand method is not specified in the contract, payment will be made at two times the cost of machine method specified under section 403. When no contract items for pavement are specified, payment will be as provided in 109.04.

5.1.6 Work ordered under 3.1.9.1 for snow removal related work will be paid for under Item 1008 Alterations and Additions as Needed – Winter Maintenance, when included in the contract.

5.1.7 All winter maintenance related work will be paid for under respective contract items or subsidiary to 619.

5.2 Pavement markings will be paid for as provided in subsection 632.5.

5.2.1 Temporary pavement markings required per 3.3, including maintenance, removal and disposal, will be subsidiary.

5.3 Obliteration of pavement markings will be paid for as provided in subsection 632.5.

5.4 Work ordered under 3.1.10 that resulted from Department or Municipal maintenance operations will be paid for as provided in 109.04.

5.5 Unless an item is included in the contract for relocation or removing signs, only the relocation of Type A signs will be paid for as provided in 109.04. All other signs covered, removed or relocated as provided in 3.1.3 will be subsidiary.

5.6 The accepted quantity of portable changeable message signs and trailer mounted speed limit signs will be paid for at the contract unit price complete, for each unit used. Payment will be made periodically based on the anticipated need for each unit.

5.6.1 The accepted quantity of portable changeable message sign (unit\week) and trailer mounted speed sign will be paid for at the contract unit price complete. Payment will be made based on the use for each unit, whether used once or multiple times during a week.

SECTION 619

Pay items and units:

619.1	Maintenance of Traffic	Unit
619.25	Portable Changeable Message Sign	Unit
619.253	Portable Changeable Message Sign	Unit\Week
619.27	Trailer Mounted Speed Limit Sign	Unit
619.273	Trailer Mounted Speed Limit Sign	Unit\Week

SECTION 621 -- DELINEATORS

Description

1.1 This work shall consist of furnishing and installing retroreflective delineators with or without posts as shown on the plans.

Materials

2.1 Delineator posts shall be flanged channel section steel conforming to AASHTO M 183/M 183M posts, galvanized in accordance with AASHTO M 111. The post shall be 2-1/16 inch (52 mm) wide, and 29/32 inch (22 mm) deep with a weight per foot of 1.12 lb (mass per meter of 1.67 Kg). The post shall have 3/8 inch (9 mm) holes drilled or punched, before galvanizing, at 1 inch (25 mm) on center along the center line of the web, beginning 13/32 inch (10 mm) from the top and continuing 29 inch (725 mm) down the post. Posts shall be a minimum of 6.0 ft (1.8 m) and a maximum of 7.0 ft (2.1 m) long.

2.2 Sheet material for delineators shall be sized to the dimensions and shapes shown on the plans and shall conform to one of the following:

2.2.1 Aluminum sheeting conforming to ASTM B 209 (ASTM B 209M), Alloy 6061-T6 when 0.080 inch (2 mm) thick or ASTM B 209 (ASTM B 209M), Alloy 5052-H38 when 0.100 inch (2.5 mm) thick, or

2.2.2 High-impact, ultraviolet resistant thermoplastic meeting the following minimum requirements:

PROPERTY	TEST METHOD	MINIMUM PROPERTY REQUIREMENT
Tensile Strength @ yield, psi (Mpa)	ASTM D 638 (ASTM D 638M)	5,000 (34.5)
Impact Strength @ 73 °F (23 °C), Ft. lb/in notch (N-m/m)	ASTM D 256	10 (534)
Impact Strength @ -40 °F (-40 °C), Ft. lb/in notch (N-m/m)	ASTM D 256	1.5 (80)

Flexural strength		
1/4 in @ 73 °F, psi, MPa	ASTM D 790	8,000
(6 mm @ 23 °C)	(ASTM D 790M)	(55)

Flexural modulus		
1/4 in @ 73 °F, psi	ASTM D 790	300,000 0
(6 mm @ 23 °C, MPa)	(ASTM D 790M)	(2,070)

With a minimum thickness of 0.08 inch (2 mm), or

2.2.3 Steel conforming to ASTM A 635/A 635M, galvanized in accordance with AASHTO M 111 (ASTM A 123) with a minimum thickness of 12 gauge (2.8 mm) .

2.3 Retroreflective sheeting shall conform to AASHTO M 268 (ASTM D 4956) minimum of Type III sheeting, silver/white or yellow.

2.4 Bolts for post mounting shall be aluminum alloy economy hexagon head machine bolts conforming to ASTM F 468 (ASTM F 468M) Alloy 6061-T6 supplied with vandal resistant nuts. Bolts for concrete barrier mounting shall be stainless steel hexagon head machine bolt conforming to ASTM A 276 Type 304 with an expansion anchor bolt embedded in the concrete as shown on the plans.

Construction Requirements

3.1 Steel posts for delineators shall be installed at the locations shown on the plans. Posts may be set or driven and shall be plumb. Bent or damaged posts shall be replaced.

3.1.1 When posts are set, holes shall be dug to the proper depth. Holes shall be backfilled with suitable material in layers not over 6 inch (150 mm) in depth and thoroughly compacted.

3.1.2 When posts are driven, a suitable driving cap shall be used. After driving, the top of the posts shall have substantially the same cross sectional dimensions as the body of the post. Posts shall not be driven with the assembly attached.

3.1.3 When rock is encountered in erecting posts, the depth to be drilled into the rock and any required grouting shall be determined by the Engineer.

3.2 Each retroreflective delineator shall be securely bolted to posts, guardrail or barrier as required.

Method of Measurement

4.1 Delineators will be measured by the number of delineators of the type specified.

4.1.1 Retroreflective delineator faces, of the type specified will be measured by the number of faces required.

Basis of Payment

5.1 Delineators or retroreflective delineator faces will be paid for at the contract unit price per each of the type specified, complete in place.

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Pay items and units:

621.1	Retroreflective Median Barrier Delineator	Each
621.2	Retroreflective Beam Guardrail Delineator	Each
621.11	Retroreflective Median Barrier Delineator (White)	Each
621.12	Retroreflective Median Barrier Delineator (Yellow)	Each
621.21	Retroreflective Beam Guardrail Delineator (White)	Each
621.22	Retroreflective Beam Guardrail Delineator (Yellow)	Each
621.31	Single Delineator with Post	Each
621.32	Double Delineator with Post	Each
621.321	Double Delineator with Post (White)	Each
621.322	Double Delineator with Post (Yellow)	Each
621.33	Single Delineator Double Faced with Post	Each
621.331	Single Delineator Double Faced with Post (White)	Each
621.332	Single Delineator Double Faced with Post (Yellow)	Each
621.34	Double Delineator Double Faced with Post	Each
621.341	Double Delineator Double Faced with Post (White)	Each
621.342	Double Delineator Double Faced with Post (Yellow)	Each
621.4	Retroreflective Delineator Face	Each
621.41	Retroreflective Delineator Face (White)	Each
621.42	Retroreflective Delineator Face (Yellow)	Each
621.5	Retroreflective Bridge Rail Delineator	Each

SECTION 622 -- MARKERS AND BOUNDS

Description

1.1 This work shall consist of furnishing and erecting witness markers and bounds in accordance with and at the locations shown on the plans.

Materials

2.1 Witness markers shall be studded "T" posts galvanized steel conforming to ASTM A 499. Galvanizing shall conform to AASHTO M 111 (ASTM A 123). The post shall be 1-3/8 inch (34 mm) wide, and 1-3/8 inch (34 mm) deep with a weight (mass) per foot (meter) of 1.33 lb (1.98 kg). Post shall have a 5 inch (125 mm) high by 4 inch (100 mm) wide and 3/32 in (2 mm) thick anchor plate riveted or swaged approximately 12 inch (300 mm) from the bottom. Posts shall be 7 ft (2.1 m) long.

2.2 Concrete bounds shall be as shown on the plans with Concrete Class A conforming to 520, and reinforcing steel conforming to 544.

2.3 Stone bounds shall be cut from hard and durable granite and shall be free from seams which would impair their structural integrity; solid quartz or feldspar veins will not be cause for rejection. Dimensions shall be 4 to 8 inch (100 to 200 mm) square by not less than 4 ft (1.2 m) in length. The top of the bound shall be roughly perpendicular to the length of the stone and shall have a 1/2 inch (13 mm) drill hole at least 1/2 inch (13 mm) deep near or at the center.

2.4 Backfill shall conform to 209.2.1.2.

Construction Requirements

3.1 Witness markers shall be set plumb and firm to mark ditch line drainage structures, ends of cross culverts, ends of slope drains and underdrains, or as ordered. Markers will not be used for pipes 36 inch (900 mm) and over.

3.1.1 Witness markers shall be installed 30 in (750 mm) in the ground.

3.2 Concrete Bounds.

3.2.1 Bounds shall be set as ordered on the right-of-way lines, at the beginning and end of the project, at the beginning and ends of curves, at the beginning and ends of spirals, at angle points, and on tangents. The maximum distance between bounds shall be 1,000 ft (300 m).

3.2.2 The exact location for each bound will be established from reference stakes set by the Engineer, and those reference stakes shall not be removed until the position of the bound has been checked by the Engineer.

3.2.3 The excavation shall be made to sufficient depth to allow the bound to protrude above the natural ground surface 4 inch (100 mm) if in land to be mowed, 6 inch (150 mm) if in land not under cultivation, or 12 inch (300 mm) if in woodland. Bounds in the roadway slope shall be set to protrude not more than 6 inch (150 mm) on the low side. Bounds set in lawn areas shall be set flush with the existing ground. Bounds set in pavement areas shall be recessed approximately 1/2 inch (13 mm) from the pavement surface. The bound shall be set with the letters "NH" to read from the road, and the backfill shall be thoroughly tamped in place.

3.2.4 Unless otherwise ordered, when rock is encountered, the bounds, may be cut off as required and shall be firmly bonded to the rock as directed.

3.2.5 When a tree or heavy root is encountered in setting a bound, a steel pin at least 12 inch (300 mm) long and 3/4 inch (19 mm) in diameter shall be driven when ordered. The bound shall then be set at the nearest practicable location as directed.

3.3 Stone Bounds.

3.3.1 Stone bounds shall be set at points shown or ordered in accordance with 3.2 except that 3.2.1 and references to letters "NH" in 3.2.3 will not apply.

3.4 Resetting.

3.4.1 Bounds to be reset shall be removed and reset without causing damage to the bounds.

Method of Measurement

4.1 Witness markers, concrete bounds, and stone bounds of the type specified will be measured by the number of each installed or reset.

Basis of Payment

5.1 The accepted quantities of witness markers, concrete bounds, stone bounds, and bounds reset will be paid for at the contract unit price per each for the kind specified complete in place.

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5.1.1 All excavation required for this work is subsidiary except for ordered excavation of solid rock for bounds will be paid as provided in 109.04.

5.1.2 No extra allowance will be made for handling of bounds to be reset or for any excavation required to remove bounds from their original sites.

5.1.3 Pins used as specified in 3.2.5 will be subsidiary.

Pay items and units:

622.1	Steel Witness Markers	Each
622.2	Concrete Bounds	Each
622.4	Stone Bounds	Each
622.51	Setting Bounds	Each
622.52	Resetting Bounds	Each

SECTION 624 -- RAILROAD PROTECTION

Description

1.1 This item shall consist of securing flagging service and devices from the Railroad for the protection of railroad traffic during the progress of the work. The item shall include the services of all flagmen, switch tenders, pilots, conductors, watchmen, and similar protective labor; the installation and operation of gates, bell systems, warning lights, and other protective devices, all as required by the Railroad to protect the operation and assure the safety of its equipment. The service shall be secured by the Contractor, who shall reimburse the Railroad.

Method of Measurement

4.1 This item will be measured as a unit.

Basis of Payment

5.1 Railroad protection will be paid for at the contract lump sum price.

5.2 No claim will be entertained by the Engineer for any adjustment of this item. When no quantity for this item is included in the proposal, the work required under 1.1 will not be paid for separately but will be considered as subsidiary.

Pay item and unit:

624	Railroad Protection	Unit
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SECTION 625 -- LIGHT POLE BASES**Description**

1.1 This item shall consist of concrete light pole bases constructed at the locations and of the design shown on the plans or as ordered.

Materials

2.1 Concrete shall be Class B conforming to Section 520.

2.2 Granular backfill shall be gravel conforming to 209.2.1.2.

Construction Requirements

3.1 Light pole bases shall be either precast or cast in place.

3.1.1 When precast bases are used, the hole shall be dug wide enough to allow for proper placement and compaction of the required backfill. The bases shall be placed on a prepared surface which shall provide a firm foundation. Where rock or unstable soil is encountered, the material shall be excavated 6 inch (150 mm) below the bottom of the base, and granular backfill placed and compacted in place of the excavated material.

3.1.2 When bases are to be cast in place, the holes shall be dug wide enough to allow the placement of concrete of the required diameter. Except when solid rock is encountered, the excavation shall be made to the full depth required on the plans. When solid rock is encountered, the bottom of the hole shall be at least 3 ft (1.0 m) from the top of the base and the concrete shall be firmly bonded to the rock with approved anchor rods. Forms will be required for the top of the light pole base only to a minimum distance of 12 inch (300 mm) below the finished grade of the ground at the base. Sufficient excavation shall be made about that elevation to allow the proper placement of the forms and the proper placement and compaction of the required backfill.

3.2 After the precast bases have been set, or after the removal of the forms for cast-in-place bases, granular backfill shall be placed in the entire space outside the bases, to the level of the finished grade unless otherwise ordered. Backfill shall be made in layers not greater than 6 inch (150 mm), with each layer thoroughly compacted.

Method of Measurement

4.1 Light pole bases will be measured by the number of units installed.

4.1.1 When more than 3 ft (1 m) of conduit, measured horizontally, is required to be installed from the center of the base, the first 3 ft (1 m) will be subsidiary.

Basis of Payment

5.1 The accepted quantities of light pole bases of the type required will be paid for at the contract unit price for each complete in place.

5.1.1 There will be no separate payment for excavation and granular backfill.

SECTION 625

Pay items and units:

625.1	Concrete Light Pole Bases, Type A	Each
625.11	Concrete Light Pole Bases, Type A (For Highway Lighting)	Each
625.2	Concrete Light Pole Bases, Type B	Each
625.22	Concrete Light Pole Bases, Type B (For Highway Lighting)	Each
625.9	Concrete Light Pole Bases, Special Type	Each
625.99	Concrete Light Pole Bases, Special Type (For Highway Lighting)	Each

SECTION 628 -- SAWED PAVEMENT

Description

1.1 This work shall consist of sawing concrete pavement, bituminous pavement, or both, as shown on the plans or as ordered.

1.2 This work shall consist of saw cutting grooves, routing the grooves and sealing with joint sealant at the end of the concrete bridge deck at locations indicated on the plans or as ordered.

Construction Requirements

3.1 Concrete pavement or bituminous pavement to be sawed shall be accurately marked before sawing.

3.1.1 Sawed bituminous pavement for bridge, points shall be marked on curbs at the end of the concrete bridge deck to aid in locating the end of the deck after pavement placement.

3.2 The equipment used to saw concrete or bituminous pavement shall be capable of sawing the pavement as shown on the plans or as ordered and shall produce a substantially vertical and sound face without deformation of the adjacent pavement. The use of methods other than sawing (i.e. cutting wheels, pavement breakers), which deform the pavement or leave an unsound face, will not be permitted.

3.3 Contraction joints to be cut in concrete pavement shall be cut to the width and depth as shown on the plans and filled with the type of filler shown on the plans.

3.3.1 Grooves to be cut in bridge pavement shall be cut and routed to the width and depth as shown on the plans and filled with the type of filler shown on the plans.

3.4 Concrete pavement or bituminous pavement to be sawed in connection with laying pipes, roadway excavation, constructing curb, and the like shall be sawed to a sufficient depth to permit breaking the pavement at the cut.

3.4.1 Where the pavement is found to consist of an overlay of bituminous pavement above a concrete slab, the cut shall be increased enough to score the underlying concrete so that the concrete may be broken in a reasonably uniform manner.

Method of Measurement

4.1 Sawed pavement of the type specified will be measured by the linear foot (linear meter).

Basis of Payment

5.1 The accepted quantity of sawed pavement will be paid for at the contract unit price per linear foot (linear meter).

5.1.1 No separate payment will be made for filler.

5.2 Payment will be made under 628.3 only when bituminous concrete pavement and concrete pavement are sawed one above the other.

Pay items and units:

628.1	Sawed Concrete Pavement	Linear Foot (Linear Meter)
628.2	Sawed Bituminous Pavement	Linear Foot (Linear Meter)
6.28.22	Sawed Bituminous Pavement (Bridge)	Linear Foot (Linear Meter)
628.3	Sawed Pavement	Linear Foot (Linear Meter)

SECTION 632 -- RETROREFLECTIVE PAVEMENT MARKINGS

Description

1.1 This work shall consist of furnishing, placing and removing white or yellow retroreflective paint pavement markings, preformed retroreflective tape pavement markings, and retroreflective thermoplastic pavement markings at locations shown on the plans or as ordered.

1.2 This work shall consist of furnishing and installing raised pavement markers, including cutting the pavement, at locations shown on the plans or as ordered and as required by the manufacturer.

Materials

2.1 Traffic Paint shall be ready-mixed white or yellow paint which may be used as a base for drop-on reflecting glass beads, or for use as a plain non-reflective traffic paint suitable for either bituminous or concrete surfaces. White or yellow traffic paint shall meet the requirements of the current Department of Transportation specifications for White or Yellow Traffic Paint as specified in section 708.

2.1.1 Traffic paint shall be prequalified for use. To prequalify a product, manufacturers shall supply a sample from each lot manufactured to the Bureau of Materials & Research for verification testing. Acceptable lots will be included on the Traffic Paint Batch List available at and maintained by the Bureau of Materials and Research. Final acceptance will be subject to testing of materials sampled at the project. Each batch of paint delivered to the project shall be accompanied by a document issued by

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the supplier identifying the manufacturer, product, batch number and date of manufacture. Field sampling will be performed in accordance with NHDOT Test Procedure C1.

2.2 Glass beads conform shall conform to AASHTO M 247 and shall be Type 1 with a moisture resistant coating.

2.3 Preformed retroreflective pavement marking tape shall conform to ASTM D 4505, Type V or VI, Grade B, C, D or E. Longitudinal lines, legends and symbols, except the word "ONLY" and arrows, shall be Type V. Transverse markings and the word "ONLY" and arrows shall be Type VI. The tape shall be a product listed on the Qualified Products List.

2.4 Retroreflective preformed pavement marking tape for limited service life shall conform to ASTM D 4592 Type I (Removable) or Type II (Non-removable) and have a minimum thickness of 25 mil (0.65 mm (25 mil)). The tape shall be a product listed on the Qualified Products List.

2.4.1 Blackout pavement marking tape shall conform to ASTM D 4592 Type I (Removable), except that the material shall be matte black and not be retroreflective, and have a minimum thickness of 25 mil (0.65 mm (25 mil)). The tape shall be a product listed on the Qualified Products List.

2.5 Thermoplastic material shall be homogeneously composed of pigment, filler, resins and glass beads. The pre-mix glass beads shall be uniformly distributed throughout the entire thickness of material. The material, when applied in accordance with the manufacturer's recommended procedures, shall be capable of resisting deformation by traffic. The material shall be tested in accordance with AASHTO T250 requirements.

2.5.2 The binder shall be either alkyd or hydrocarbon conforming to AASHTO M249. If an alkyd thermoplastic is used, the binder shall consist of synthetic resins, at least one of which is solid at room temperature and high-boiling point plasticizers. At least 1/3 of the binder compositions shall be a maleic-modified glycerol ester resin and shall be at least 10% by weight of the total composition.

2.5.3 Thermoplastic material shall not deteriorate by contact with sodium chloride, calcium chloride or other chemicals used to prevent roadway ice. The material shall also not deteriorate because of the oil content of pavement materials or from oil droppings or other effects of traffic.

2.5.4 Material, when formed into pavement markings, shall be readily renewable by placing an overlay of the same material directly over the old markings. The new material shall bond itself to the old markings in such a manner that no splitting or separation takes place.

2.5.5 Preformed Thermoplastic material shall be composed of an resin resistant to degradation by motor fuels, lubricants etc. in conjunction with aggregates, pigments, binders, and glass beads which have been factory produced as a finished product. The thermoplastic material shall conform to AASHTO designation M249 with the exception of the relevant differences due to the material being supplied in a preformed state such as drying time and flowability tests.

2.5.5.1 Preformed thermoplastic material shall have factory applied surface beads in addition to the intermixed beads at a rate of 10 pounds per 100 square feet (5 kilograms per 10 square meters (10 pounds per 100 square feet) of markings. It also shall contain a minimum of thirty percent (30%) intermixed graded glass beads by weight.

2.5.5.2 The surface, with properly applied and embedded surface beads, shall provide a minimum resistance value of 45 BPN when tested according to ASTM E 303.

2.5.5.3 The material shall be applied at a thickness of 90 mils.

2.6 **2.6** Raised pavement markers shall be retroreflective markers as included on the Qualified Products List.

2.7 Snowplowable raised pavement markers shall consist of an iron casting with a retroreflector for reflecting light from a one or two way traffic direction adhesively attached within the casting.

2.7.1 Casting material shall be nodular iron conforming to ASTM A 536, Grade 72-45-05, hardened to 52-54 RC. The forward and rear noses of the casting shall be shaped to deflect snowplow blades. Castings shall have a center rail or the reflector unit shall have a cast iron center bar/canopy as a deterrent to reflector damage. Castings shall be a maximum of 10 in (254 mm (10 in) long by 6.5 in (162.5 mm (6.5 in) wide by 1.85 in (46 mm (1.85 in) high with a maximum installed height above the roadway of 0.30 in (7.5 mm (0.30 in). The surface of the keel and web shall be free of scale, dirt, rust, oil, grease and other contaminants which may reduce its bond to the installation adhesive. Casting shall be marked with the manufacturer's name and model number.

2.7.2 Reflector shall consist of an acrylonitrile butadiene styrene (ABS) shell containing one or two reflective inserts to reflect incident light from a single or opposite directions. The reflector shall be laminated to an elastomeric pad and adhesively attached to the casting.

2.7.2.1 Reflector shall be a nominal dimension of 4 in x 2 in x 0.48 in (100 mm x 50 mm x 12 mm). The reflector surface shall be at a slope of 30 degrees. The area of the reflective surface shall be a minimum of 1.47 in² (95 mm² (1.47 in²). The elastomeric pad shall be 0.04 in (1 mm (0.04 in) thick.

2.7.2.2 The reflector inserts shell shall be molded methyl methacrylate conforming to ASTM D 788, Grade 0131. The core material shall be of sufficient strength and resilience to pass the necessary physical requirements.

2.7.2.3 Thin untempered glass shall be bonded to the reflector faces to provide a hard and durable abrasion resistant surface.

2.7.3 Pavement markers shall meet the following testing criteria, performed and certified by the supplier.

2.7.3.1 Optical testing shall be performed on 50 randomly selected reflectors.

2.7.3.1.1 Steel Wool Abrasion Procedure. Form a 1 in (25 mm (1 in) diameter flat pad using #3 coarse steel wool per Federal Specification F-W-1825. Place the steel wool pad on the reflector lens. Apply a load of 50 lb. (23 kg (50 lb.)) and rub the entire lens surface 100 times. (Note: On two color units, the red lens may not be glass covered and, if so, should not be abraded.)

2.7.3.1.2 Specific Intensity. After abrading the lens surface, using the above steel wool abrasion procedure, the specific intensity of each white (clear) reflecting surface at 0.2° observation angle shall not be less than the following when the incident light is parallel to the base of the reflector.

Horizontal Entrance Angle	Specific Intensity (cd/FC)		
	White	Yellow	Red
0°	3.0	1.8	0.75
20°	1.2	0.72	0.30

2.7.3.1.3 Optical Testing Procedure. The light source shall have an effective diameter of 0.2 in (5 mm (0.2 in) and be arranged so that light is at the same height as the center of the retroreflector, 5 ft

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(1.5 m (5 ft) for the reflector, and shine parallel to the base of the reflector. The photocell shall be placed 0.21 in (5 mm (0.21 in) to the side of the light source so that the angle from the center of the light source to the center of the retroreflector, to the photocell is 0.2 degrees (Observation Angle). If different test distance is selected, the 0.2 degree observation angle shall be maintained.

The photocell shall be shielded to eliminate the entrance of light not coming from the retroreflector. All other light sources shall be extinguished to insure the only light reaching the photocell is light reflected from the test source.

Two readings shall be taken. First, with the light illuminating the retroreflector from an angle perpendicular to the bottom edge of the reflector. The second, with the light illuminating the retroreflector at 20 degrees from perpendicular.

Failure of more than 4% of the reflecting faces shall be cause for rejection of the lot.

2.7.3.2 A random sample of three markers shall be selected for strength testing purposes.

2.7.3.2.1 Strength Requirement. Markers shall support a load of 11,000 lb (5,000 kg (11,000 lb) as applied in the following manner.

2.7.3.2.2 Strength Testing Procedure. Remove tape from markers. Position marker base down at the center of 0.5 in (13 mm (0.5 in) thick flat steel plate. Apply a load to the top center of the marker by means of a 1.0 in (25 mm (1.0 in) diameter solid steel plug at a rate of 0.03 in (0.76 mm (0.03 in) per minute. Failure shall constitute either breakage or significant deformation of the marker at any load less than 11,000 lb (.5,000 kg (11,000 lb.).

2.7.3.3 A random sample of three markers shall be selected for bond strength testing purposes.

2.7.3.3.1 Bond Strength Testing Procedure. Remove release paper from the bottom of the marker. Apply currently approved adhesive to the face of a sand blasted 1 in (25.4 mm (1 in) steel test plug and position the plug on the center of the marker. Apply a compressive force of 75 lb. (110 N (75 lb.) to the test plug for 6 seconds. After 72 hours cure at 73.4 °F ± 3.6 °F (23° C ± 2° C (73.4° F ± 3.6° F), cut through the adhesive along the circumference of the pipe cap to limit area of adhesive to be tested. Attach to test plug and marker assembly to the platens of a tensile testing machine and separate the platens at a rate of 0.03 in (0.76 mm (0.03 in) per minute. Bond strength of less than 10 lb. (4.5 kg (10 lb.) total shall be considered a failure.

2.7.3.4 Pressure Sensitive Adhesive Test Procedure. A retroreflector shall be adhered to a flat 1/4 in (6 mm (1/4 in) thick carbon steel plate, with 60 psi (410 kPa (60 psi) 480 lb. (217 kg (480 lb.) minimum application pressure. Both the top of the retroreflector and the bottom of the flat plate shall have fastened to it an appropriate coupling devise to ensure compatibility with the tensile testing device. The test sample shall be tested in the tensile mode at a pull rate of 2 in (50 mm (2 in) per minute. Minimum load to produce failure shall be 250 lb. (112 kg (250 lb.) at 70 °F (20° C (70° F).

2.7.3.5 Three reflectors shall be selected for heat resistance test.

2.7.3.5.1 Heat Resistance Procedure. Three reflectors shall be conditioned for four hours in a circulating air oven at 175 °F ± 5 °F (80° C ± 3° (175° ± 5° F). The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the conditioning the samples shall be removed from the oven and permitted to cool in air to room temperature. The samples after exposure to heat shall show no significant change in shape and general appearance when compared with corresponding unexposed control standards. There shall be no failures.

2.7.3.6 Seal Test Procedure. A sample of 50 units shall be submerged in water at room temperature and subjected to a vacuum of 5 inches gauge for five minutes. After restoring atmospheric pressure the units shall be left submerged for an additional five minutes. When examined for water intake, failure of more than one unit shall be cause for rejection.

2.7.3.7 A random sample of markers, to provide 20 lenses for impact testing, shall be selected from each lot. (Note: On two color units, the red lens may not be glass covered and if so should not be subjected to impact test.)

2.7.3.7.1 Impact Testing. Remove reflectors from the castings and scrape adhesive residue from the bottom of the reflectors. Condition the reflectors in a convection oven at 130 °F (55° C (130° F) for one hour. While at the elevated temperature, impact the reflective face by allowing a 0.42 lb. (190 gm (0.42 lb.) dart fitted with a 0.25 in (.64 mm (0.25 in.) radius spherical head to drop 18 in. (457 mm (18 in.) perpendicularly onto the center of the reflective surface. Cracks in the impact area shall be generally concentric in appearance. There shall be no more than two radial cracks longer than 0.25 in. (6.4 mm (0.25 in.). There shall be no radial cracks extending to the edge of the glass.

2.7.3.7.2 Temperature Cycling. Subject samples to 3 cycles of 140 °F (60° C (140° F) for 4 hours followed by 20 °F (-7.0° C (20° F) for 4 hours. There shall be no cracking or delamination of the glass following temperature cycling.

2.7.3.7.3 Tolerances. In either the impact or temperature cycling test, if 90% (18 lenses) of the test samples meet the above requirements, the lot shall be acceptable. Failure of 3 lenses of the sample shall be cause of rejection of the lot.

Construction Requirements

3.1 General.

3.1.1 All pavement markings of the type specified shall be applied at the locations shown on the plans or as ordered, and shall be in accordance with the MUTCD. Traffic control operations in conjunction with placing markings shall conform to 619 and the Traffic Control Plan.

3.1.1.1 The Contractor shall establish the base line points at 50 ft (20 m (50 ft) intervals on curves and 100 ft (40 m (100 ft) intervals on tangent sections throughout the length of pavement to be marked under this section from the Department provided control points. All other pavement markings shall be applied according to the physical pavement layout provided. The Contractor shall provide the pavement marking layout on the top pavement to the Engineer at least 3 days unless otherwise prior permitted prior to installation of the permanent pavement markings.

3.1.1.2 Whenever existing pavement marking patterns are to be obscured and later restored, the Contractor shall take detailed measurements of all existing pavement markings to permit the Contractor to accurately prepare drawings to reproduce those patterns. Reproduced markings shall be placed in the correct location laterally to reflect the intended lane and shoulder widths as specified in the Contract or as directed. The Contractor shall also perform a good quality videotape survey showing all pavement markings in each direction of travel with appropriate audio description of location and direction. The drawings and videotape shall be submitted to the Engineer prior to obscuring any pavement markings on the project.

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3.1.1.3 The Contract Administrator shall be notified of the day and time of the pavement markings application a minimum of 48 hours prior to the application unless otherwise approved. This notification must be acknowledged. No payment will be made for materials placed without proper notification.

3.1.1.4 In the event the Contractor cannot place pavement markings per 619.3.3 and NHDOT Work Zone Traffic Control Standard Plans the Bureau of Traffic shall be notified a minimum of 48 hours before the end of this period in order to apply applicable pavement markings. No item payment will be made and a callout charge of \$2,500.00 plus \$500.00 per mile of striping for this application will be deducted from moneys due the Contractor. In case of cancellation or the Contractor placing the pavement markings after notification, the callout charge will apply unless the Bureau of Traffic is notified by telephone at least 24 hours prior to the event.

3.1.2 Longitudinal lines placed on tangent roadway segments shall be straight and true. Longitudinal lines placed on curves shall be continuous smoothly curved lines consistent with roadway alignment. All pavement markings placed shall meet the tolerance limits shown on the plans.

3.1.3 Broken lines shall consist of 10 ft (3 m (10 ft) line segments with 30 ft (9 m (30 ft) gaps and shall meet the tolerance limits shown on the NHDOT Standard Plans.

3.1.4 Reflectorized paint and thermoplastic pavement markings shall be applied in one pass at the width specified; preformed retroreflective pavement marking tape and thermoplastic shall be applied at the full width specified. Unless otherwise specified, widths of pavement marking lines shall be as follows:

Line Type	Width — in (mm (in)	
	Interstate*	All Other Applications
Centerlines	N/A	4 (100 (4)
Edgelines	6 (150 (6)	4 (100 (4)
Lane Lines	6 (150 (6)	4 (100 (4)
Gore Markings	12 (300 (12)	8 (200 (8)
Crosswalk Lines	N/A	6 (150 (6)
Parking Space Markings	N/A	4 (100 (4)
**Stop Lines	N/A	18 (450 (18)

* Interstate criteria may be used on other divided highway facilities where shown on the plans or ordered.

** Stop Lines can be applied in three passes if necessary

3.1.5 Newly applied pavement markings shall be protected from traffic until the material has cured. The method of protection shall not constitute a hazard to the traveling public. As a minimum, when striping two-way roadways, an escort vehicle shall precede and another shall follow the pavement marking truck. On one-way divided roadways, at least two escort vehicles shall follow the truck to protect pavement markings from traffic. Additional escort vehicles may be required on multi-lane roadways. Damage to any markings as a result of tracking shall be repaired by the Contractor at no cost to the Department.

3.1.6 The use of pavement markings other than in their final location on wearing course will only be permitted if the marking material is designed to be removed without the use of heat, solvent, grinding or blast treatment, and leaves no visible scar on the surface.

3.1.7 The Contractor shall furnish and have available for the Engineer's use a pavement temperature gauge.

3.2 Retroreflective Pavement Marking Paint.

3.2.1 All equipment used for highway striping shall be specifically designed and manufactured for that purpose by a company experienced in the design and manufacture of such equipment and approved for use. Equipment used for longitudinal lines shall be mounted on a truck having a minimum gross vehicle weight rating of 14,000 lb (6350 kgg (14,000 lb) with a minimum paint tank capacity of 60 gal (225 L (60 gal), and shall have the capability of placing double lines up to 4 in (100 mm (4 in) in width or single lines up to 12 in (300 mm (12 in) in width in one pass. Each paint tank shall have metal plate or plates attached in a prominent place, plainly marked with the maximum filled capacity of the tank. Each tank shall have a mixer capable of combining and maintaining the ingredients of the paint into a thoroughly mixed and uniform mass. The paint shall be applied with an atomizing or airless spray type striping machine having the waterbase paint at a temperature of 105 °F (40 °C (105 °F) maximum in the heat exchanger and 85 – 105 °F (30 – 40 °C (85 – 105 °F) at the spray nozzle. Paint shall pass through a screen with a maximum opening of 1/8 of an inch (3.175 mm (1/8 of an inch) located before the heat exchanger. A valve accessible for sampling shall be located in the paint feed line between the screen and the heat exchanger. The striping machine shall be equipped with an automatic paint stripe controller having skip-line capability to place broken lines in accordance with 3.1.3 and the NHDOT Standard Plans. A gauge reading paint temperature shall be mounted and conveniently displayed on the equipment. The equipment shall include a mechanical, glass-bead dispenser mounted not more than 12 in (300 mm (12 in) behind the paint dispenser. All equipment shall be kept in good operating condition.

3.2.1.1 Vehicles and equipment will be subject to inspection by the Bureau of Traffic at their office located in Concord at least once per year prior to the first application of material and as frequently as considered necessary thereafter. Yearly inspection shall be arranged with a ten working day notification. Approved vehicles will receive a seal for that year. If found unfit to function properly, the vehicle will be disapproved for use until correct operating conditions have been obtained.

3.2.2 Immediately before applying the pavement marking paint to the pavement, the Contractor shall insure the surface is dry and entirely free from dirt, sand, grease, oil, or other matter which would prevent effective adhesion of the paint to the pavement.

3.2.3 The surface temperature of the pavement shall be a minimum of 40 °F (5 °C (40 °F).

3.2.3.1 Every effort shall be made to apply paint according to the requirements stated in this section. When paint must be applied between the dates of October 15 through April 15 inclusive or on pavement with a surface temperature below 40 °F (5 °C (40 °F), cold weather paint can be used which does not exceed EPA's Federal Register/Rules and Regulations (40 CFR Part 59 [AD-FRL-6149-7] RIN 2060-AE55), as amended, for VOC content limit and shall meet the AASHTO M248 F and requirements noted below. These products shall be applied according to the manufacturer's requirements. Prior to October 15, cold weather retroreflective paint pavement marking materials may be used if the pavement marking contractor has changed over to cold weather retroreflective paint pavement marking material. After April 15, the pavement marking contractor may use up the existing remaining supply of cold weather retroreflective paint pavement marking material in stock.

3.2.3.1.1 The Contractor shall provide a copy of their cold weather paint specification and a sample of each batch to the Bureau of Materials & Research per spec. 708.03 – Approval, Sampling and Testing for approval. Each batch sample shall include lab test results verifying that the paint meets their specification. Refer to the Traffic Paint Batch list for approved cold weather paints. The cold weather paint shall meet the following minimum requirements.

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<i>Property</i>	<i>Test Method</i>	<i>Requirement</i>
Dry Opacity (contrast ratio)	ASTM D2244 – with a wet film thickness of 15 mil	0.96 Min.
VOC	ASTM D3960	1.25 lb/gal (150 g/l (1.25 lb/gal) Max.
Drying time	ASTM D7111 with wet film thickness of 15 mils	15 Minutes max @ 77 °F (25°C (77°F)

3.2.3.1.2 The thickness of the paint and the bead application shall be at the manufacturers recommendation. This information shall be stated in their specification submittal with batch sample and also provided to the Engineer.

3.2.3.1.3

3.2.4 Paint shall be applied to a thickness of 20 mil (0.50 mm).

3.2.5 Glass beads shall be evenly applied through the entire paint thickness at a rate of 8 pounds to each gallon (0.96 kilograms to each liter (8 pounds to each gallon) of water base or alkyd paint. Glass beads shall be applied simultaneously with paint, by pressurized or mechanical drop methods.

3.2.6 All clean up and disposal of solvents, residue, and the like shall be the responsibility of the Contractor and shall be performed in accordance with all applicable federal, state, and local regulations.

3.2.7 The Contractor shall furnish and have available for the Engineer's use the following inspection equipment:

Wet Film Thickness Gauge: Scales which range from: 2 to 30 mils in 2 mil increments (200 to 700 μ m in 25 μ m increments (2 to 30 mils in 2 mil).

Pocket Microscope: Scope having a four-part lens system with magnification of 20x and a clip-on accessory light.

Striping Calibration Kit: Volumetric bead calibration kit shall be complete with instructions, as manufactured by Potters Industries, Inc., or approved equal.

3.2.7.1 Contractor shall measure all paint tanks (white & yellow) with paint stick prior to painting and after to determine the amount of gallons used. Contractor shall also provide the Engineer their footage at the end of striping by zeroing out or recording the footage on their footage meters prior to and at the end of striping. All footage meters shall be able to measure white & yellow separately.

3.2.8 Painted lane lines, edgelines, and centerlines shall have a minimum retroreflectivity of 200 millicandelas for white and 150 millicandelas for yellow. The retroreflectivity measurement will be taken by the Department on lines that are clean and dry within 30 days of application, before any winter maintenance takes place.

Retroreflectivity measurements will be taken with LTL 2000 retrometer having 30 meter geometry in accordance with ASTM E 1710. All readings shall be taken with the test instrument centered on the line.

A group of 10 retroreflectivity tests will be taken in a random 100 ft (30-meter (100 ft.) length for each 2 miles (3.2 km (2 miles.) or less of line length. A minimum of two groups of 10 retroreflectivity tests will be taken for each line per project. No more than 5% of all tests taken for each line shall be below the minimum retroreflectivity. When this requirement is not met, the entire line will be restriped at no additional expense to the Department. The Contractor shall provide traffic control and line cleaning for testing, as requested by the Engineer. Traffic control and line cleaning, will be subsidiary to Item 619 and Item 632 respectively.

3.3 Preformed Retroreflective Pavement Marking Tape.

3.3.1 Preformed pavement marking tape shall be applied at locations shown on the plans by mechanical or manual methods. Mechanical applications shall be suitable for all markings. Manual applications shall normally be used for transverse lines, symbols and legends. The manufacturer shall provide technical assistance for equipment operation and maintenance, and product applications.

3.3.2 Preformed pavement marking tape shall be stored and applied as directed by the manufacturer. All markings applied after September 1 of any year shall be applied using the inlay method, unless specifically permitted by the Engineer. Prior to September 1, application by either the inlay or overlay method will be permitted, unless otherwise specified. When the inlay method is used, paving and marking operations shall be coordinated to meet the manufacturer's recommendations.

3.3.2.1 For the inlay method, the pavement markings shall be embedded in the pavement surface with a conventional steel wheel roller. The surface temperature of the pavement shall be within the range specified by the manufacturer and shall not deform or discolor the markings.

3.3.2.2 When applying pavement markings by the overlay method, the pavement surface shall be clean, dry and above the minimum temperature as specified by the manufacturer. The surface shall be broomed clean and all dust shall be removed using compressed air. When required by the manufacturer, a coat of primer/adhesive activator shall be applied.

3.3.3 The Contractor shall provide a copy of the manufacturer's storage and application recommendations and the manufacturer's certificate of compliance to the Engineer upon delivery of the material to the project. The certificate shall include the process, batch, or lot number(s) and corresponding date(s) of manufacture.

3.3.4 The required quantity of preformed pavement marking tape shall be available at the project prior to the start of applicable paving operations.

3.3.4.1 Material shall be delivered to the project in original containers. Each container shall be clearly marked to indicate the color of the material, a specific description of the contents, and the process batch or lot numbers.

3.3.4.2 Material found to be discolored or damaged in any way or material manufactured more than one year prior to installation shall not be used.

3.4 Retroreflective Thermoplastic Pavement Marking.

3.4.1 Thermoplastic pavement markings shall be applied to the road surface in a molten state by screed/extrusion or spray means with a surface application of glass beads.

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3.4.1.1 All equipment used to apply thermoplastic pavement markings shall be constructed to provide continuous uniform heating at temperatures exceeding 400 °F (204 °C (400 °F) during mixing and agitation of the material. Equipment used for longitudinal lines shall be mounted on a truck having a minimum gross vehicle weight of 14,000 lb (6,350 kg (14,000 lb), and shall have the capability of placing double lines up to 4 in (100 mm) in width or single lines up to 12 in (300 mm) in width in one pass. The equipment shall operate so that all mixing and conveying parts, including the line dispensing device, maintains the material at the required plastic temperature. The use of pans, aprons or similar appliances which the dispenser overruns will not be permitted. The thermoplastic material shall be applied by the screed/extrusion method. Spray method application may be used only for legends and arrows. The striping machine shall be equipped with an automatic stripe controller having skip-line capability to place broken lines in accordance with 3.1.3 and the NHDOT Standard Plans, and a glass bead dispenser located immediately behind the material dispenser. All equipment shall be kept in good operating condition.

3.4.1.2 A special kettle shall be provided for uniformly melting and heating the thermoplastic material. The kettle shall be equipped with an automatic thermostat control device and material thermometer for positive temperature control and to prevent overheating or underheating of the material. The heating kettle and application equipment shall meet the requirements of the National Fire Underwriters, the National Fire Protection Association and state and local authorities.

3.4.2 Immediately before applying the thermoplastic to the pavement, the Contractor shall insure the surface is dry and entirely free from dirt, sand, grease, oil, or other matter which would prevent effective adhesion of the thermoplastic material to the pavement.

3.4.2.1 When recommended by the manufacturer of the thermoplastic material, a primer/sealer shall be applied to the pavement surface prior to the application of the thermoplastic material. The primer shall be void of solvent and water prior to the thermoplastic application.

3.4.3 Thermoplastic pavement marking materials shall not be applied by the screed/extrusion method when air and/or pavement surface temperatures are below 50 °F (10 °C) or by the spray method when air/or and pavement surface temperatures are below 55 °F (13 °C), or when the surface of the pavement contains any evidence of moisture.

3.4.4 Thermoplastic material shall be applied to the pavement at a thickness of 125 mils (3.2 mm (125 mils) for screed/extrusion application and 90 mils (2.3 mm (90 mils) for spray applications.

3.4.5 Glass beads shall be evenly applied to the surface of the completed marking at a rate of 10 pounds per 100 square feet (5 kilograms per 10 square meters) of markings. Glass beads shall be applied by pressurized or mechanical drop methods.

3.4.6 All clean up and disposal of solvents, residue, and the like shall be the responsibility of the Contractor and shall be performed in accordance with all applicable federal, state and local regulations.

3.4.7 Preformed thermoplastic pavement markings shall be a resilient white thermoplastic product with uniformity distributed glass beads throughout the entire cross sectional area. The markings shall be resistant to the detrimental effects of motor fuels, lubricants, hydraulic fluids etc. The markings can be used for stop lines, legends, symbols, and crosswalks, and shall be capable of being affixed to bituminous concrete pavements by the use of the normal heat of a propane torch.

3.4.7.1 The markings shall be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics, such that they are capable of fusing with themselves and previously applied thermoplastic when heated with the torch.

3.4.7.2 The marking must be able to be applied on pavement with a surface temperature down to 40 °F (5°C) without any preheating of the pavement to a specific temperature.

3.5 Raised pavement markers shall be used as shown on the plans or the MUTCD in the same color as specified for pavement markings.

3.5.1 Pavement shall be cut to match the bottom contours of the marker casing and the dimension specified by the manufacturer to hold the snow plowable pavement marker in the pavement at the height specified.

3.5.2 Snow plowable pavement markers shall be installed at the locations shown on the plans according to the manufacturers recommendations.

3.6 Obliteration of Pavement Markings.

3.6.1 Pavement marking obliteration shall result in a minimum of pavement scar and shall obliterate all evidence of the existing pavement marking material. Removal may be performed by grinding, sand or water blasting, blackout tape, or other method(s) approved by the Engineer that do not materially damage the pavement surface.

3.6.2 “Painting” over pavement markings with paint, asphalt mixtures or any other material is prohibited.

3.6.3 Removal and disposal of pavement markings including, but not limited to retroreflective paint, retroreflective thermoplastic, preformed retroreflective tape and raised pavement markers shall be the responsibility of the Contractor in accordance with all applicable federal, state, and local regulations.

Method of Measurement

4.1 Retroreflective pavement marking lines of the type and width specified will be measured by the linear foot (linear meter), to the nearest foot (meter) of length of marking applied.

4.1.1 Double lines and combination solid/broken lines will be measured as separate lines according to the length of each individual marking applied.

4.2 Retroreflective pavement marking symbols or words of the type specified will be measured by the square foot (square meter), to the nearest 0.1 of a square foot (0.01 of a square meter) of area applied, based on established areas as shown on the Standard Sheets (Plans).

4.3 Repair work ordered under 3.1.5 will not be measured.

4.4 Raised pavement markers will be measured by each for each marker installed.

4.5 Obliterate pavement marking lines of the type specified will be measured by the linear foot (linear meter), to the nearest foot (meter) of length of marking, with no adjustment for width.

4.6 Obliterate pavement marking symbols or words of the type specified will be measured by the square foot (square meter), to the nearest 0.1 of a square foot (0.01 of a square meter of area, based on established areas as shown on the Standard Sheets (Plans).

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Basis of Payment

5.1 The accepted quantities of retroreflective pavement marking lines of the type and width specified will be paid for at the contract unit price per linear foot (linear meter) complete in place.

5.1.2 If preformed retroreflective tape, removable is ordered it will be paid for as extra work on a force account basis in accordance with 109.04(D).

5.2 The accepted quantities of retroreflective pavement marking symbol or words of the type specified will be paid at the contract unit price per square foot (square meter) complete in place.

5.3 Additional equipment or labor necessary to apply preformed retroreflective pavement marking tape by the inlay method will be subsidiary.

5.4 The accepted quantities of raised pavement markers will be paid for at the contract unit price for each marker installed. The unit price will include replacement as needed, and the removal and disposal of each marker in accordance with 3.6.3.

5.5 The accepted quantities of obliterate pavement marking lines will be paid for at the contract unit price per linear foot (linear meter). Payment will not be made for the removal of removable pavement marking tape.

5.6 The accepted quantities of obliterate pavement marking symbols or words of the type specified will be paid for at the contract unit price per square foot (square meter). Payment will not be made for the removal of removable pavement marking tape.

KEY TO ITEM NUMBERS FOR PAVEMENT MARKINGS

Item Number		Unit
632	.A B C D	Item number
632		Section number
	.A	Material
	B	Type of marking
	C D	Width of line
<u>.A Material:</u>		
	.0 Retroreflective Paint	
	1 Preformed Retroreflective Tape, Type I (Removable)	
	.2 Preformed Retroreflective Tape, Type II (Non-Removable)	
	.3 Retroreflective Thermoplastic	
	.4 Blank	
	.5 Preformed Retroreflective Tape, Type V	
	.6 Preformed Retroreflective Tape, Type VI	
	.81 Raised Pavement Marker - Single Face	Each
	.82 Raised Pavement Marker - Double Face	Each
	.851 Snow Plowable Raised Pavement Marker (One-Way)	Each
	.852 Snow Plowable Raised Pavement Marker (Two-Way)	Each
	.9 Obliterate Pavement Marking	
<u>B Type of Marking:</u>		
	._1 Line	Linear Foot (Linear Meter)

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Symbol		Square Foot (Square Meter)
CD	Width of Line (English)	
__04	4 in	Linear Foot
__06	6 in	Linear Foot
__08	8 in	Linear Foot
__12	12 in	Linear Foot
__16	16 in	Linear Foot
__24	24 in	Linear Foot
CD	Width of Line (Metric)	
__10	100 mm	Linear Meter
__15	150 mm	Linear Meter
__20	200 mm	Linear Meter
__30	300 mm	Linear Meter
__45	450 mm	Linear Meter
__60	600 mm	Linear Meter
CD	Width of Line (English)	
__04	4 in	Linear Foot
__06	6 in	Linear Foot
__08	8 in	Linear Foot
__12	12 in	Linear Foot
__16	16 in	Linear Foot
__24	24 in	Linear Foot

Examples (ENGLISH):

632.0104	Retroreflective Paint Pavement Marking, Single Solid Line, 4 in	Linear Foot
632.3104	Retroreflective Thermoplastic Pavement Marking, Single Solid Line, 4 in	Linear Foot
632.5104	Preformed Retroreflective Tape, Type V, 4 in Line	Linear Foot

Examples (METRIC):

632.0110	Retroreflective Paint Pavement Marking, 100 mm Line	Linear Meter
632.3110	Retroreflective Thermoplastic Pavement Marking, 100 mm Line	Linear Meter
632.5110	Preformed Retroreflective Tape, Type V, 100 mm Line	Linear Meter

SECTION 641

SECTION 641 -- LOAM

Description

1.1 This work shall consist of collecting and preparing loam material encountered in the work or obtained from other sources, and placing the material at the locations shown on the plans or ordered, including necessary excavation for placing loam.

Materials

2.1 Loam shall consist of loose friable topsoil with no admixture of refuse or material toxic to plant growth. Loam shall be generally free from stones, lumps, stumps, or similar objects larger than 2 inch (50 mm) in greatest diameter, subsoil, roots, and weeds. The term as used herein shall mean that portion of the soil profile defined technically as the "A" horizon by the Soil Science Society of America. The minimum and maximum pH value shall be from 5.5 to 7.6. Loam shall contain a minimum of 3 percent and a maximum of 10 percent of organic matter as determined by loss by ignition. Not more than 65 percent shall pass a No. 200 (0.075 mm) sieve as determined by the wash test in accordance with ASTM D 1140. In no instance shall more than 20% of that material passing the No. 4 (4.75 mm) sieve consist of clay size particles.

2.1.1 Natural topsoil not conforming to 2.1 or containing excessive amounts of clay or sand shall be treated by the Contractor to meet those requirements.

Construction Requirements

3.1 The loam shall be spread upon the previously prepared subgrade surface to the depth of 4 inch (100 mm) \pm 1/2 inch (13 mm) unless otherwise specified and shall be raked carefully to remove all objectionable materials. Loam shall be spread in such a manner as to establish a loose, friable seedbed. In order to maintain a consistent grade, loam placed adjacent to lawns or where directed shall be compacted with a roller weighing approximately 100 pounds per foot (150 kilograms per meter) of roller width. All depressions exposed during the rolling procedure shall be filled with additional loam, and rolled.

Method of Measurement

4.1 Loam will be measured by the cubic yard (cubic meter) as determined by actual surface measurements of the lengths and widths of the loamed areas multiplied by the depth specified. Measurements will be made to the nearest 0.1 of a cubic yard (cubic meter).

Basis of Payment

5.1 The accepted quantities of loam of the various depths specified will be paid for at the contract unit price per cubic yard (cubic meter) complete in place.

5.2 Materials used for treating natural topsoil as in 2.1.1 will be subsidiary.

Pay item and unit:

641 Loam

Cubic Yard (Cubic Meter)

SECTION 642 -- LIMESTONE**Description**

1.1 This work shall consist of furnishing and applying limestone on areas shown on the plans or ordered.

Materials

2.1 Limestone shall be a calcic or dolomitic ground agricultural limestone containing not less than 95 percent of either calcium or magnesium carbonate, or both. It shall conform to the standards of the Association of Official Agricultural Chemists and shall comply with all State and Federal rules and regulations.

2.1.1 Sieve analysis. A minimum of 40 percent shall pass a No. 100 (0.150 mm) sieve, and a minimum of 95 percent shall pass a No. 8 (2.36 mm) sieve.

2.1.2 Packaging. Limestone shall be furnished in new, clean, sealed, and properly labeled bags, of not more than 100 lb (50 kg) each, with the following information clearly marked thereon:

- (a) Manufacturer's name.
- (b) Type.
- (c) Weight.
- (d) Guaranteed analysis.

2.1.2.1 Caked or otherwise damaged limestone may be rejected.

2.2 Other liming materials may be used if permitted.

Construction Requirements

3.1 Limestone shall be used when ordered, to raise the pH of the soil, at a rate determined by the Engineer in accordance with Table 1.

Table 1 - Limestone Required to Raise Soil pH to a Minimum pH of 5.5

Existing Soil pH	Limestone to Be Added	
	Tons/Acre (Metric Tons/Hectare)	Pounds/Cubic Yard (Kilograms/Cubic Meter)
4.0 - 4.4	3 (6.75)	12 (7.2)
4.5 - 4.9	2 (4.50)	8 (4.8)
5.0 - 5.4	1 (2.25)	4 (2.4)

3.2 Limestone shall be applied by either the dry or hydraulic methods specified in 644.3.5.

SECTION 642

Method of Measurement

4.1 Limestone will be measured by the ton (metric ton), in accordance with 109.01, on the basis of delivery slips forwarded to the Engineer, but not to exceed the rate ordered. Measurements will be made to the nearest 0.01 of a ton (metric ton).

Basis of Payment

5.1 The accepted quantity of limestone will be paid for at the contract unit price per ton (metric ton) complete in place.

Pay item and unit:

642	Limestone	Ton (Metric Ton)
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SECTION 643 -- FERTILIZER FOR GRASSES

Description

1.1 This work shall consist of furnishing and applying an initial application of fertilizer on a new surface and one or more refertilizations after the growth has progressed sufficiently, all as shown on the plans or as ordered.

Materials

2.1 Fertilizer shall be a standard commercial grade fertilizer conforming to all State and Federal rules and regulations and to the standards of the Association of Official Agricultural Chemists. The analysis shall represent respective percentages of nitrogen, phosphoric acid, and potash.

2.1.1 Except as permitted, the analysis ratio shall be 1:1:1 for initial application and 3:1:2 for refertilization application. The analyses in Table 1 are preferred. Permission to furnish fertilizer with an analysis varying from Table 1 will be based upon reasons given in writing by the Contractor requesting such variances.

Table 1 - Fertilizer Information

Percent of Nutrients		Minimum Application Rate Lbs Per 1,000 ft ² (kg per 100 m ²)	Measurement Factor
Initial	Refertilization		
10-10-10		20.0 (9.8)	1.0
15-15-15		13.4 (6.5)	1.5
19-19-19		10.5 (5.1)	1.9
	10-3-6	20.0 (9.8)	1.0
	12-2-8	16.7 (8.1)	1.2
	12-4-8	16.7 (8.1)	1.2

2.1.2 A minimum of 30 percent of the nitrogen in fertilizer used for refertilization shall be water insoluble (WIN).

2.2 All fertilizer shall be identified by labels and shall show the following:

- (a) Guaranteed analysis.
- (b) Name and address of the guarantor of the fertilizer.
- (c) Type or brand.
- (d) Net weight.

2.2.1 When furnished as a liquid, the fertilizer shall be delivered in an appropriate container or vehicle, and shall conform to the pertinent sections of the Fertilizer Rules and Regulations issued by the New Hampshire Department of Agriculture.

Construction Requirements

3.1 Fertilizer shall be uniformly applied by either the dry or hydraulic method specified in 644.3.5. When the dry method is used, special care shall be taken to thoroughly work the fertilizer into the soil.

3.1.1 The rate of application shall be based upon the nitrogen content and shall be a rate between 2.0 and 2.2 pounds (0.98 and 1.07 kilograms) of nitrogen per 1,000 square feet (100 square meters). See Table 1 for typical application rates.

3.2 Unless otherwise ordered, not less than three months shall elapse between the initial fertilization and the refertilization. No refertilization ordinarily will be allowed between November 1, or when the ground has frozen, and the following April 1, or between June 1 and the following September 1. Refertilization will be allowed between August 15 and 31 only when it is determined that the permanent grasses have developed well and few weeds have appeared, and such refertilization will not tend to promote the growth of noxious weeds.

Method of Measurement

4.1 Fertilizer will be measured by the pound (kilogram) or by the ton (metric ton), and in accordance with Section 109.01, on the basis of weight slips or delivery slips forwarded to the Engineer, but not to exceed the maximum rate specified or ordered. Measurements by the ton (metric ton) will be made to the nearest 0.01 of a ton (metric ton).

4.1.1 The quantity for payment will be the product of the accepted quantity used and the appropriate measurement factor from Table 1.

Basis of Payment

5.1 The accepted quantity of fertilizer will be paid for at the contract unit price per pound (kilogram) or per ton (metric ton) complete in place.

Pay items and units:

643.11	Fertilizer for Initial Application	Pound (Kilogram)
643.12	Fertilizer for Initial Application	Ton (Metric Ton)
643.21	Fertilizer for Refertilization	Pound (Kilogram)
643.22	Fertilizer for Refertilization	Ton (Metric Ton)

SECTION 644

SECTION 644 -- GRASS SEED

Description

1.1 This work shall consist of furnishing and sowing grass seed as shown on the plans or as ordered.

Materials

2.1 General.

2.1.1 Grass seed shall meet the requirements of the New Hampshire Agricultural and Vegetable Seeds Law. As specified in the law, the mixture shall include no "primary noxious weed seeds".

2.1.2 Grass seed of the specified mixtures shall be furnished in fully labeled, standard, sealed containers.

2.1.3 Percent germination and purity of each seed type in the mixture and weed seed content of the mixture shall be clearly stated on the label.

2.1.4 Seed shall be subject to the testing provisions of the Association of Official Seed Analysts. The month and year of test shall be clearly stated on the label.

2.1.5 Seed may be tested after it has been delivered to the project.

2.1.6 Seed which has become wet, moldy, or otherwise damaged will not be acceptable.

2.2 Park seed Type 15 shall normally be used on loam areas. This seed mixture shall conform to Table 1.

Table 1 - Park Seed Type 15

Kind of Seed	Minimum Purity (%)	Minimum Germination (%)	Pounds/Acre (Kilograms/Hectare)
Creeping Red Fescue ^c	96	85	40 (45)
Perennial Ryegrass ^a	98	90	50 (55)
Kentucky Bluegrass ^b	97	85	25 (30)
Redtop	95	80	5 (5)
			TOTAL 120 (135)

2.3 Slope seed (WF) Type 45 shall normally be used for all slope work, and shall conform to Table 2 unless amended by the Engineer to suit special local conditions encountered.

Table 2 – Slope Seed (WF) Type 45

Kind of Seed	Minimum Purity (%)	Minimum Germination (%)	Application Rate [lbs/acre (kg/ha)]
Creeping Red Fescue ^c	96	85	35 (40)
Perennial Ryegrass ^a	98	90	30 (35)
Redtop	95	80	5 (5)
Alsike Clover	97	90 ^e	5 (5)
Birdsfoot Trefoil ^d	98	80 ^e	5 (5)
Lance-Leaved Coreopsis	95	80	3(3)
Oxeye Daisy	95	80	3(3)
Butterfly Weed	95	80	3(3)
Blackeyed Susan	95	80	3(3)
Wild Lupine	95	80	3 (3)
Total			95 (105)

2.3.1 Slope seed Type 44 shall normally be used for slope work where wildflowers are not suitable for use, and shall conform to Table 3.

Table 3 - Slope Seed Type 44

Kind of Seed	Minimum Purity (%)	Minimum Germination (%)	Pounds/Acre (Kilograms/Hectare)
Creeping Red Fescue ^c	96	85	35 (40)
Perennial Ryegrass ^a	98	90	30 (35)
Redtop	95	80	5 (5)
Alsike Clover	97	90 (e)	5 (5)
Birdsfoot Trefoil ^d	98	80 (e)	5 (5)
TOTAL			80 (90)

NOTES TO TABLES 1 & 2:

^a Ryegrass shall be a certified fine-textured variety such as Pennfine, Fiesta, Yorktown, Diplomat, or equal.

^b Bluegrass shall be a certified variety such as Merion, Baron, Majestic Touchdown, Nugget, Ram One, or equal.

^c Fescue varieties shall include - Creeping Red and/or Hard Reliant, Scaldis, Koket, or Jamestown.

^d Empire variety preferred) Inoculum specific to birdsfoot trefoil must be used with this mixture. The inoculum shall be a pure culture of nitrogen-fixing bacteria selected for maximum vitality and the ability to transform nitrogen from the air into soluble nitrates and to deposit them in the soil. The inoculum shall not be used later than the date indicated on the container or later than specified. The inoculum shall be subject to approval.

^e Includes not more than 10 percent hard seed for alsike clover and not more than 25 percent hard seed for birdsfoot trefoil. If necessary, to meet this requirement, extra seed shall be supplied at no expense to the Department.

2.4 Crownvetch (Chemung, Pengift and Emerald variety preferred) shall be used at the rate of 10 pounds per acre (11.2 kg/ha) with or without slope seed on all slopes designated on the plans to be seeded with crownvetch or as ordered. Generally crownvetch will be required on steep slopes, usually 3:1 or steeper, and on other critical areas of poor soil conditions with susceptibility to erosion forces.

SECTION 644

2.4.1 Inoculum specific to crownvetch must be used with this seed. In all other respects it shall conform to note (d) in Table 2.

2.4.2 Crownvetch seed shall have a minimum of 35 percent normal sprouts and 35 percent hard seed. If necessary, to meet this requirement, extra seed shall be supplied at no expense to the Department.

Construction Requirements

3.1 General.

3.1.1 In order to prevent unnecessary erosion of newly graded slopes and unnecessary siltation of drainage ways, the Contractor shall carry out erosion control items of work such as seeding and mulching as soon as it has satisfactorily completed a unit or portion of the project, such as a structure, an interchange, or a section of roadway.

3.1.2 When immediate protection of newly graded areas is necessary at a time which is outside of the normal seeding season, hay mulch shall be applied in accordance with 645.3.1.1, with the seeding done at the same time or done later, or both as ordered.

3.1.2.1 When immediate seeding is required on areas of the roadside which are not to be regraded or disturbed, one of the above specified seed mixtures shall be used as ordered.

3.1.2.2 Areas of the roadside which are to be left temporarily and which will be regraded or otherwise disturbed later during construction may be ordered to be seeded with ryegrass under Item 645.52 to obtain temporary control. Ryegrass shall be spread at the rate of approximately 1 pound per 1,000 square feet (0.5 kilograms per 100 square meters).

3.1.3 The Engineer reserves the right to prohibit the use of any equipment that is unsuitable or inadequate for the proper performance of the work. The Contractor must immediately remove all rejected equipment from the project.

3.1.4 When the seed mixture requires an inoculum, the inoculum shall be kept as cool as possible, at all times below 75 °F (25 °C) until used. Inoculated seed shall be protected from exposure to sunlight prior to sowing, and all seed not sown within 24 hours following inoculation shall be properly reinoculated.

3.1.4.1 When grass seed is to be sown dry and the specific legume seed such as birdsfoot trefoil or crownvetch requiring inoculation is furnished on the project separately from the balance of the seed mixture, the legume seed shall be inoculated using twice the normal quantity recommended by the supplier, and, regardless of the directions by the supplier, the seed shall be treated with a sticking agent to hold the inoculum to the seeds, and then treated with a drying agent. The sticking agent shall consist of a mixture such as 9:1 solution of water and molasses, which shall be thoroughly mixed with the seed at the rate of 1/2 pint per 100 pounds (1/2 liter per 100 kilograms) of seed, unless a greater rate is recommended by the supplier. Before mixing the treated seed with the remainder of the seed mixture, a drying agent such as cornstarch shall be added at the rate of approximately 1/2 pound per 100 pounds (1/2 kilogram per 100 kilograms) of seed, unless another rate is specified.

3.1.4.2 When grass seed is to be sown dry and the legume seed is furnished on the project already mixed with the remainder of the seed mixture, 3 times the normal quantity of inoculant recommended by the supplier as sufficient for the quantity of legume in the mixture shall be mixed with the total seed. The sticking agent and the drying agent shall be mixed in the manner and at the rate specified in 3.1.4.1 with sufficient agents to treat the entire mixture.

3.1.4.3 When the seed is to be applied by the use of a hydraulic seeder, at least 4 times the normal amount of the appropriate inoculum, required to inoculate only the legume shall be added to the mixture just before application. See 3.5.2.7.

3.2 Seeding Seasons.

3.2.1 Seeding and initial fertilizing shall be done between April 1 and June 1, between August 15 and October 14, or as permitted. Seeding shall not be done during windy weather or when the ground is frozen, excessively wet, or otherwise untillable. If seeding is done during July or August, additional mulch material may be required by the Engineer.

3.3 Application rates. Unless specifically ordered, seed shall be spread at the rates specified in 2.2, 2.3, and 2.4.

3.4 Preparation.

3.4.1 All areas to be seeded shall be prepared to provide a reasonably firm but friable seed bed.

3.4.1.1 Sloped areas shall not be left too smooth; the surface shall be left in a ruffled condition such as may be produced by the use of tracked vehicles run up and down the slopes. Smooth, compacted slopes, such as may be left from blading, which might allow the free flow of water down them shall be disked, harrowed, dragged with a chain or mat, machine-raked, or hand-worked as directed to give the effect of miniature terraces, particularly in silty or clayey soils. The slopes shall be left smooth enough to enable mowing.

3.4.1.2 Lawn areas, such as where loam has been spread, shall be prepared for seeding in accordance with 641.3.1.

3.4.2 All areas to be seeded shall meet the specified grades and shall be free of growth and debris.

3.4.3 Care shall be taken to prevent the formation of low places and pockets where water will stand.

3.4.4 Where ryegrass has been planted for temporary erosion control and has not been eliminated prior to the completion of the work, such areas shall be disc-harrowed at least 3 inch (75 mm) deep and seeded with permanent grasses to prevent the ryegrass from reseeding and becoming competitive with and retarding development of the permanent cover.

3.5 Seeding methods. Fertilizer, limestone, and mulch material if required, and seed of the type specified may be placed at the locations shown or ordered by one of the following methods, provided an even distribution is obtained.

3.5.1 Dry Method.

3.5.1.1 Powerequipment. Mechanical seeders, seed drills, landscape seeders, cultipacker seeders, fertilizer spreaders, or other approved mechanical seeding equipment or attachments may be used when seed, limestone, and fertilizer are to be applied in dry form.

3.5.1.2 Manual equipment. On areas which are inaccessible to power equipment, permission may be given to use hand-operated mechanical equipment when the materials are to be applied in dry form. The use of hand shovels to spread the materials will not be allowed.

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3.5.1.3 When the dry method is used, limestone and fertilizer shall not be mixed together prior to their application, but they shall be worked into the soil together to the depth of at least 1 inch (25 mm).

3.5.1.4 At least 24 hours shall elapse between the time fertilizer is incorporated and the seed is planted.

3.5.1.5 Loamed areas or areas covered with park seed shall be raked, and, unless rolling is ordered omitted, shall be rolled with a roller weighing not more than 100 pounds per foot (150 kilograms per meter) of roller width to firm the soil but not to pack it. The rolling shall be done the same day as the seeding unless otherwise permitted.

3.5.1.6 Unless otherwise ordered, areas covered with park seed, or slope seed with or without crownvetch shall be mulched in accordance with 645. Private lawns affected by this specification need not be mulched unless it is requested by the landowner.

3.5.2 Hydraulic Method.

3.5.2.1 The application of grass seed, fertilizer, limestone, and a suitable wood fiber mulch shall be accomplished in one operation by use of an approved spraying machine.

3.5.2.2 The materials shall be mixed with water in the machine and kept in an agitated state in order that the materials may be uniformly suspended in the water.

3.5.2.3 The spraying equipment shall be so designed that when the solution is sprayed over an area, the resulting deposits of limestone, fertilizer and grass seed shall be equal in quantity to the required rates.

3.5.2.4 Prior to the start of work, the Engineer shall be furnished with a certified statement for approval as to the number of pounds (kilograms) of materials to be used per 100 gallons (100 liters) of water. This statement shall also specify the number of square feet (square meters) of seeding that can be covered with the quantity of solution in the hydroseeder.

3.5.2.5 The hydroseeder shall be completely flushed and cleaned each day before seeding is to be started, and shall also be thoroughly flushed of all residue after the completion of application on every 10 acres (4 hectares).

3.5.2.6 If the results of the spray operations are unsatisfactory, the Contractor will be required to abandon this method and apply the materials in accordance with 3.5.1.

3.5.2.7 When inoculum is required, if the inoculum is left in solution with fertilizer longer than 30 minutes, a fresh charge of inoculum (4 times normal) shall be added to the mixture. See 3.1.4.3.

3.5.2.8 When the hydraulic method is used, compaction or rolling will not be required.

3.5.2.9 Except as provided in 3.1.2, unless mulch material required is applied during the seeding operation or within 1/2 hour following the seeding operation, temporary and satisfactory measures to protect the seed from sunlight and heat shall be taken, such as the use of a light brush drag over the seeded areas to stir the seed into the soil. Care shall be taken not to carry the seed ahead.

3.6 Care After Seeding.

3.6.1 The Contractor shall be responsible for protecting and caring for seeded areas until Acceptance of the Work. He shall repair at his own expense any damage to seeded areas caused by pedestrian or vehicular traffic or other causes, except for conditions as covered in 104.13.

3.6.2 If necessary, barricades of brush or other materials and suitable signs shall be placed to protect the seeded areas.

3.6.3 The seeded areas shall be carefully and suitably watered as necessary to produce a satisfactory growth.

3.6.4 Areas seeded with park seed shall be mowed whenever necessary to keep the growth between 3 and 6 inch (75 and 150 mm) in order to allow light to penetrate to the shorter, slower growing species in the mixture. Areas seeded with slope seed may be ordered mowed whenever the contract extends into a second growing season.

3.6.5 Weeds growing in areas seeded with the slope seed shall be cut back to prevent them from dominating the desired grass plants.

3.7 Liability.

3.7.1 The Contractor shall keep all seeded areas in good repair.

3.7.2 To be acceptable, a stand of grass shall show a reasonably thick, uniform stand, free from sizable areas of thin or bare spots, with a uniform count of at least 100 plants of specified grass per square foot (1,100 plants per square meter). When applicable, at least 3 birdsfoot trefoil plants and 1 crownvetch plant per square foot (32 birdsfoot trefoil plants and 11 crownvetch plants per square meter) must be visible with the other specified grasses.

3.7.3 Any part of seeded areas which fail to yield an acceptable stand shall be retreated with additional seed, limestone, fertilizer and mulch as ordered at no cost to the Department.

Method of Measurement

4.1 Grass seed shall be measured by the (pound) (kilogram) based upon the delivery slips and tags furnished the Engineer, but not to exceed the rate specified or ordered.

Basis of Payment

5.1 The accepted quantity of grass seed will be paid for at the contract unit price per pound (kilogram) of the type specified complete in place.

5.1.1 Seeded areas which need reseeding will be done at the Contractor's expense.

5.2 Hay mulch will be paid for as provided under 645.

5.3 Limestone will be paid for as provided under 642.

5.4 Fertilizer will be paid for as provided under 643.

5.5 Ryegrass will be paid for as provided under 645.

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Pay items and units :

644.15	Park Seed Type 15	Pound (Kilogram)
644.44	Slope Seed Type 44	Pound (Kilogram)
644.45	Slope Seed (WF) Type 45	Pound (Kilogram)
644.51	Birdsfoot Trefoil	Pound (Kilogram)
644.6	Crownvetch Seed	Pound (Kilogram)

SECTION 645 -- EROSION CONTROL

Description

1.1 Permanent control. This work shall consist of furnishing and placing hay mulch, bark mulch, wood, straw or coconut fiber mat, synthetic mat, paper mat, jute mesh or other material as a soil stabilization product for erosion control on slopes or ditches for protection to hold the ground and/or cover material (sod, seed, etc.) in place, at locations shown on the plans or where ordered.

1.1.1 Slope stabilization (2:1 or flatter) shall be material installed on slopes 2:1 (H:V) or flatter.

1.1.2 Slope stabilization (steeper than 2:1) shall be material installed on slopes steeper than 2:1.

1.1.3 Channel stabilization (low velocity) shall be material installed in channels or ditches with a velocities equal to or less than 9 ft/s (2.75 m/s).

1.1.4 Channel stabilization (high velocity) shall be material installed in channels or ditches with a velocity greater than 9 ft/s (2.75 m/s).

1.1.5 Permanent stabilization shall be permanent material installed on slopes or in channels.

1.2 Temporary erosion control. This work shall consist of furnishing, stockpiling, installing, sowing, maintaining, and removing temporary erosion and sediment control devices at locations shown on the plans, or where ordered. Erosion control devices examples are: temporary seeding, silt fence, hay bales, temporary mulch, and erosion stone.

1.3 Storm Water Pollution Prevention Plan (SWPPP). This work shall consist of a temporary Erosion and Sediment Control and Stormwater Management Plan, hereinafter called the "Plan". The work includes all necessary preparations for submissions and revisions of the Plan to obtain approval by the Department. This work shall also include monitoring the approved Plan during all phases of construction.

1.3.1 The Department will furnish the following data to the Contractor:

- Specific reproducible plan sheets and cross-sections of the project, as requested,
- Drainage calculations and plans (drainage area size and characteristics; runoff volume; type, size, and slope of pipes; invert elevations; and outlet velocities), as available,
- Geotechnical Report including soil boring logs, soil types, and test pit data, as available,
- Permits and certifications obtained for the project, and
- A list of environmental commitments.

- A copy of the NHDOT's Notice of Intent application.
 - A copy of the NHDOT's Acknowledgement letter from EPA
 - Documentation of permit eligibility related to federally listed threatened and endangered species
- NHDES Wetlands Permit "Plan of Record".

1.3.2 Recommended guides for the preparation of the Plan are the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP). July 1, 2003 (68 FR 39087) The AASHTO Highway Drainage Guideline, Volume III, *Guidelines for Erosion and Sediment Control in Highway Construction*, available from the American Association of State Highway and Transportation Officials, Inc., 444 North Capitol St. N.W., Suite 249, Washington, D.C. 20001; the *Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire* available from the New Hampshire Department of Environmental Services (NHDES) Public Information and Permitting Office, PO Box 95, 6 Hazen Drive, Concord, NH 03302-0095, Telephone (603) 271-2975 and the Rockingham County Conservation District in Exeter, NH, Telephone (603) 772-4385; the NHDOT Guidelines for Temporary Erosion and Sediment Control and Stormwater Management (May 2002).

1.3.3 The Plan shall be consistent with the provisions of 107.01.

Materials

2.1 Hay mulch shall consist of cured hay, free from noxious weeds and rough or woody materials.

2.1.1 Bark mulch shall be bark chippings graded to be approximately 3/8 to 2 in (10 to 50 mm) in width. The chippings shall not have been stored so long and under such conditions that the material has decomposed sufficiently so that it has lost its fibrous texture. Bark mulch must be approved as to grading and condition prior to its use.

2.1.2 Temporary mulches may be hay, straw, fiber mats, netting, wood cellulose, bark, chips or other acceptable material and shall be reasonably clean and free of noxious weeds and materials toxic to plant growth.

2.1.3 Other types of mulch as included on the Qualified Products List may be used.

2.2 Soil stabilization materials of the type specified shall be a product as included on the Qualified Products List. The material furnished for use shall be of sufficient construction and strength to hold the processed ground and/or cover material (sod, seed, etc.) in place until an acceptable growth of natural or planted material is established.

2.3 Staples for soil stabilization material matting shall be those specified by the manufacturer.

2.4 Grass seed for erosion control shall be one of the following:

- (a) Seed for temporary control shall be a quick growing species suitable to the area, such as annual or perennial ryegrass, providing a temporary cover which will not compete with the grasses subsequently sown for permanent cover.
- (b) Seed for a more permanent control shall be of the type specified in the plans or as set forth in 644.2.3.

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2.5 Hay bales for erosion control shall consist of rectangular shaped bales of hay or straw weighing at least 40 lb. (18 kg) per bale. They shall be free from weed seeds and rough or woody materials.

2.6 Tackifiers shall be as included on the Qualified Products List.

2.7 Geotextile filter fabric for silt fence shall be made from polypropylene, polyester, or other approved polymeric chemically stable material and be resistant to ultraviolet radiation degradation for at least 12 months. Silt retention capacity shall be no less than 75 percent of silt and suspended solids. The fabric shall meet the following requirements.

Fabric Property	Test Method	Property Requirement*
Grab Tensile Strength (lbs (N))	ASTM D 4632	100 (450) Minimum
Grab Tensile Elongation (%)	ASTM D 4632	25 Maximum
Puncture Strength (lbs (N))	ASTM D 4833	60 (275) Minimum
Mullen Burst Strength (psi ((kPa))	ASTM D 3786	210 (1500) Minimum
Trapezoid Tear Strength (lbs (N))	ASTM D 4533	60 (275) Minimum

* All properties are minimum or maximum average roll values (i.e. the test results for any sampled roll in a lot shall meet or exceed the minimum values or be less than or meet the maximum value in the table.)

2.8 Posts for silt fence shall be either wood or steel. Wood posts shall be sound quality hardwood with a minimum cross sectional area of 1.6 square inches (1,033 square millimeters). Steel post shall be standard T or U section weighing not less than 1 pound per linear ft (1.5 kilograms per linear meter) with projections for fastening wire to the fence. Maximum post spacing shall be 10 ft (3 m).

2.9 Support fence for silt fence, if required, shall be a minimum of 14.5 gauge (1.9 mm) woven wire with a maximum 6 in (150 mm) mesh.

2.10 Erosion stone shall meet the requirements for Item 585.4 Class D stone.

Construction Requirements

3.1 General

3.1.1 Prior to the start of any land disturbance activities, the Contractor shall submit four sets of the Storm Water Pollution Prevention Plan (SWPPP) described in 3.2 for approval in accordance with 105.02 for clearing, grubbing, grading, drainage and bridge structures, especially in or adjacent to existing waters, water courses and wetlands. The Department's review time will be proportional to the complexity of the Plan and will be within 15 working days. No work requiring erosion/ sediment control shall commence until the Plan has been approved. Names of designated personnel to perform field monitoring shall be included in the submittal. The Plan may be submitted in phases or for specific construction areas. Only work within areas covered by an approved Plan will be allowed to be performed.

3.1.1.1 The Department will secure the necessary NHDES Wetlands or US Army Corps of Engineers permit(s) to accomplish the work indicated on the plans. The Contractor is responsible for obtaining additional Wetlands or Corps of Engineers permit(s) for the Contractor's method of construction.

3.1.2 Permanent and temporary erosion control features shall be incorporated into the project at the earliest practicable time, as specified on the plans, as stated in 107.01, and as outlined in the approved Plan. Temporary erosion and sediment control measures shall be used to correct conditions that develop during construction to temporarily control erosion not associated with permanent control features.

3.1.3 When erosion is likely to be a problem, grubbing operations shall be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter.

3.1.4 The amount of disturbed earth material exposed shall not exceed a total of 500,000 square feet (46,450 square meters) for all operations within the right-of-way at any one time without prior approval and provided the Contractor's Plan shows adequate provisions to control erosion and sediment. The Storm Water Pollution Prevention Plan (SWPPP) shall identify when exposed material will be protected from erosion and when temporary and permanent erosion control measures will be installed.

3.1.5 The Engineer will limit the area of grubbing, excavation, borrow and embankment operations commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and permanent erosion and sediment control measures concurrent with operations in accordance with the accepted plan.

3.1.6 Earth excavation and embankment slopes shall be permanently or temporarily treated for stabilization before the time the slant height of exposed slopes reaches 30 ft (9 m), unless otherwise approved. Where construction activities are completed within the growing season, all exposed soil areas shall be permanently stabilized within 14 calendar days. Where construction activities are temporarily suspended or completed outside of the growing season, all exposed soil areas shall be treated for stabilization within 14 calendar days.

3.1.7 As work progresses, patch seeding and mulching shall be done as required on areas previously treated to maintain or establish protective cover.

3.1.8 Drainage pipes and ditches shall be constructed in a sequence from outlet to inlet in order to stabilize outlet areas and ditches before water is directed to the new installation or any portion thereof unless conditions unique to the location warrant an alternative method. If this unique condition exists, the alternative method will require written approval.

3.1.9 Channel and ditch work, including erosion protection shall be completed before diverting the drainage to these areas.

3.1.10 In the event of conflict between these requirements and erosion and sediment control laws, rules or regulations of other Federal, State or local agencies, the more restrictive laws, rules or regulations shall apply.

3.1.11 In case of failure on the part of the Contractor to provide and maintain effective temporary erosion and sediment control, as determined by the Engineer, the Department reserves the right to employ outside assistance or to use its own forces to provide the necessary corrective measures.

3.2 Storm Water Pollution Prevention Plan. (SWPPP)

This Item addresses the preparation and implementation of a Storm Water Pollution Prevention Plan required by the National Pollutant Discharge Elimination System (NPDES) and applicable Construction General Permit (CGP). The Plan shall be prepared, stamped and signed by a Licensed Professional Engineer registered in the State of New Hampshire qualified to prepare erosion and sediment control plans, hereinafter called the "Preparer". Collaboration with other professionals such as soil scientists, geologists and environmentalists may be required as appropriate.

3.2.1.1 Qualifications for the Plan Preparer include a minimum of 5 years experience or knowledge of highway and bridge construction operations, with knowledge of methods of construction, demonstrated knowledge of erosion and sediment control, and stormwater management measures. The

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preparer shall have previously submitted accepted plans to the New Hampshire Department of Environmental Services (NHDES) under RSA 485-A:17 Terrain Alteration, or have prepared accepted plans under the National Pollutant Discharge Elimination System permit program.

3.2.1.2 Qualifications for the Plan Monitor shall include a minimum of 2 years experience or knowledge of highway and bridge construction with knowledge of methods of construction, demonstrated field knowledge of erosion control measures; their design, effectiveness, and maintenance requirements.

3.2.1.3 The Contractor shall submit the name and qualifications of the person or firm proposed to prepare the Plan to the Engineer for approval prior to preparing the Plan. Submittal of the name and qualifications will be accepted after the opening of bids.

3.2.2 The Construction General Permit (CGP) also requires the preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the afore-mentioned statutes and regulations. The Plan will include the CGP conditions and detailed descriptions of controls of erosion and sedimentation to be implemented during construction. It is the responsibility of the Contractor to prepare the SWPPP to meet the requirements of the most recently issued CGP. The Contractor shall submit the Plan to the Engineer for approval prior to any soil disturbance activities. It is the responsibility of the Contractor to be familiar with the CGP conditions and the conditions of any state Wetlands permit, Water Quality Certification, Corps of Engineers Section 404 Permit and other state and federal environmental permits applicable to this project and to include in the Stormwater Pollution Prevention Plan (SWPPP) the means and methods necessary to comply with applicable conditions of said permits.

It is the responsibility of the Contractor to complete the SWPPP in accordance with the EPA Construction General Permit, provide all information required, and obtain any and all certifications as required by the Construction General Permit. Any amendments to the SWPPP required by site conditions, schedule changes, revised work, construction methodologies, and the like are the responsibility of the Contractor. Amendments will require the approval of the Engineer prior to implementation.

The Contractor is responsible for preparation of the SWPPP, all SWPPP certifications, inspections, reports and any and all corrective actions necessary to comply with the provisions of the CGP.

3.2.2.1 A schedule of construction phasing, and a schedule for monitoring and maintaining the SWPPP shall also be included. BMP's for seasonal (i.e. cold weather/frozen ground) applications shall be identified. The construction phasing shall address the various erosion and sediment control and storm water management measures to be implemented at each phase of construction. Phases shall be as shown on the Traffic Control Plan, Prosecution of Work, or as required by the Contractor's approved schedule of operations.

3.2.2.2 Turbidity limitations in receiving waters noted in 107.01 shall be addressed in the Plan.

3.2.2.3 Department plan drawings will show the construction site(s) conditions prior to and after construction by including property lines, right-of-way lines, easements, existing and new structures, drainage, flood plains, wetlands, limits of clearing and grading, proposed final drainage, detours, permanent erosion and sediment control measures, and other critical items. The Contractor's plan drawings shall show temporary drainage and erosion and sediment control measures for the construction site(s) on the contract plans provided by the Department. Additionally the Contractor shall provide plans showing all of the above items for proposed areas related to the construction site(s) not shown on the Department's contract plans, including but not limited to, access and haul roads, equipment and material storage sites, material pits, material processing sites, and disposal areas, except municipally authorized landfill areas and commercial sites. Waste materials are quite often materials unsuitable for embankment

construction and generally very susceptible to erosion; therefore, the Contractor shall pay close attention to controlling erosion of these materials.

3.2.2.4 Additional design typicals illustrating practices for erosion and sediment control not shown on the Department plans shall be included in the Plan. Calculations shall be included to verify all erosion and sediment control and stormwater management practices such as, but not limited to, sediment retention and detention basins, energy dissipators, diversions, waterways, and control of runoff.

3.2.3 The Preparer or the Preparer's designated representative shall assist the Contractor in implementing the Plan, monitor the site for compliance with the Plan and recommend modifications to the Plan for changing operations or inadequate erosion and sediment control and stormwater management measures. The Preparer shall make modifications to the Plan as necessary and resubmit for review and approval in accordance with 3.1.1. Review time of modifications will be within 10 working days of submittal.

3.2.3.1 Monitoring SWPPP and Erosion and Sediment Control shall include on-site reviews, weekly and within 24 hours after any storm event greater than 0.5 in (13 mm) of rain per 24 hour period. A monitoring report prepared by the Plan Monitor stating the inspection date, name, title, qualifications and signature of person performing the inspection, weather information for the period since the last inspection, weather information at the time of inspection, locations and description of any discharges, a summary of construction activities undertaken during the reporting period, general site conditions, erosion control maintenance and corrective actions taken, the anticipated schedule of construction activities for the next reporting period, any SWPPP amendments, and representative photographs.

A copy shall be provided to the Engineer and maintained on file with the SWPPP at the project site.

3.2.3.2 The Engineer may order modifications to the Plan for changing operations or for inadequate erosion and sediment control and stormwater management measures. Changes and/or modifications shall be noted by the Plan Preparer on the approved Plan located at the project site.

3.2.3.3 The Preparer of the Plan shall be available for on-site consultations with the Engineer within 24 hours of request.

3.2.4 Project work may be suspended, wholly or in part, with no extension of time or additional compensation for failure to implement and maintain the approved Plan, including modifications, in accordance with 105.01.

3.3 Mulch

3.3.1 Mulching shall be done immediately after each area has been properly prepared. When seed for erosion control is sown prior to placing the mulch, the mulch shall be placed on the seeded areas within 48 hours after seeding. Hay that has been thoroughly fluffed shall be applied at approximately, but not to exceed 3 tons per acre (6.7 metric tons per hectare) unless otherwise ordered. Blowing chopped hay mulch will be permitted provided the Contractor controls the mulching operation so as not to infringe on property owners or the traveling public. Hay mulch shall be applied in such a manner that results in a minimum amount of matting that would not retard the vegetative growth. Hay mulch should cover the ground enough to shade it, but the mulch should not be so thick as to cover the ground completely. Matted or bunches of mulch shall be removed or otherwise remedied.

3.3.1.1 Temporary mulching shall be done on areas that are disturbed per 3.1.6. Hay shall be applied at a minimum of 3.2 tons per acre (8.0 metric tons per hectare) unless otherwise ordered. Blowing chopped hay mulch will be permitted provided the Contractor controls the mulching operation so as not to infringe on property owners or the traveling public. Tackifiers shall be utilized with temporary mulch.

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3.3.2 In order to prevent mulch from being blown away, a light covering of loose branches or approved tackifier shall be employed. Unless otherwise ordered, loose branches shall be removed prior to Acceptance of the Work.

3.3.3 All baling wire or rope, such as that used in the shipment of mulch, shall be disposed of outside the limits of the project in approved areas.

3.3.4 Bark mulch shall be placed on the designated areas to the depth specified on the plans or as ordered.

3.3.5 On areas treated with bark mulch, the Contractor shall remove weeds and plant material as directed.

3.4 Soil Stabilization Products.

3.4.1 Surfaces of ditches and slopes to receive soil stabilization products shall conform to the grades and cross sections shown on the plans and shall be finished to a smooth and even condition with all debris, roots, stones, and lumps raked out and removed. The soil surface shall be sufficiently loose to permit bedding of the product. Unless otherwise directed, soil shall be prepared, including the application of lime, fertilizer and seed prior to installation of the specified type of soil stabilization product.

3.4.2 Soil stabilization of any type shall be installed where shown on the plans, or as directed. Throughout the entire placement area the soil stabilization product shall be in uniform contact with the existing underlying soils and matting, if used, shall not be stretched. It is critical that this contact is achieved in order to maximize any seeding or other vegetative growth specified for this area.

3.4.3 Installation techniques and procedures shall be as recommended by the manufacturer for the particular site characteristics or as directed. Documentation from the product manufacturer regarding installation techniques and procedures shall be supplied to the Engineer at least 10 working days prior to installation.

3.4.3.1 Matting, if used, shall be buried around the edges of catch basins and other structures or obstructions as described in the manufacturer's installation requirements.

3.4.3.2 The spacing of staples may be changed as ordered, depending upon varying factors such as the season of the year or the amount of water encountered or anticipated.

3.4.4 For soil stabilization materials that become loosened, raised, or undermined, or if any matting becomes torn, or any matting staples become loose or raised, satisfactory repairs shall be made immediately.

3.5 Seed for Erosion Control.

3.5.1 Seeding, when required, shall be performed as ordered and in accordance with 644.3.

3.5.1.1 Areas of the roadside which are to be left temporarily and which will be regraded or otherwise disturbed later during construction may be ordered to be seeded with ryegrass to temporarily stabilize the area. The seed shall be sown at the rate of approximately 1 pound per 1,000 square feet (5 kilograms per 1000 square meters).

3.6 Hay bales for erosion control. Hay bales shall be placed when ordered to provide for temporary control of erosion and/or sediment control and secured with two (2) hardwood stakes. Bales shall be removed or left in place as ordered.

3.7 Silt Fence.

3.7.1 Install and remove the silt fence as shown on the plans and as recommended by the manufacturer.

3.7.1.1 When two sections of silt fence adjoin each other, they shall be overlapped by 6 in (150 mm), folded, and stapled at a post.

3.7.1.2 Support fence, when required, shall be fastened securely to the fence posts with staples or wire ties.

3.7.1.3 Filter fabric shall be fastened to the support fence, when support fence is required, with ties spaced every 2 ft (600 mm) longitudinally at the top, mid-section, and bottom.

3.7.1.4 Silt fence shall be embedded a minimum of 6 in (150 mm).

3.7.2 Care shall be taken to maintain the silt fence in a functional condition at all times during the construction period.

3.7.2.1 Silt fences shall be inspected immediately after each rainfall event and at least daily during prolonged rainfall. All deficiencies shall be immediately be corrected.

3.7.2.2 Sediment deposits shall be inspected after every storm event and removed when deposits reach approximately 1/3 the height of the silt fence, or when “bulges” develop in the silt fence.

3.7.2.3 Silt fence fabric which has decomposed, has become ineffective or does not retain silt or suspended solids and is still needed, shall be replaced immediately.

3.7.3 Remove the silt fence, support stakes and support fence after all work has been completed and it is no longer needed or as ordered.

3.7.3.1 Sediment deposits shall be removed or left in place, if approved. After the silt fence has been removed, sediment deposits allowed to be left in place shall be graded to conform with the existing topography and shall be vegetated.

3.7.3.2 The silt fence will become the property of the Contractor upon completion of the project, unless otherwise ordered.

3.8 Erosion Stone.

3.8.1 Erosion stone shall be placed to provide for temporary control of erosion or sedimentation including stone check dams, inlet control and stabilized construction entrances or where ordered. Upon acceptance of the Contract, the stone shall be removed as ordered.

3.9 Maintenance.

3.9.1 Erosion control features shall be maintained by the Contractor throughout the life of the project.

Method of Measurement

4.1 Mulch and temporary mulch will be measured by the square yard (square meter) or by the acre (hectare). When measurements are made by the acre (hectare), such measurements will be made to the nearest 0.01 of an acre (hectare).

SECTION 645

4.1.1 Bark mulch will be measured by the square yard (square meter) measured along the slope of the ground.

4.2 Matting will be measured by the square yard (square meter), based on dimensions of the matting prior to installation. Areas buried or ordered overlapped will not be deducted.

4.3 Grass seed will be measured by the pound (kilogram), as specified in 644.4.1.

4.4 Hay bales for erosion control will be measured by the number of bales installed.

4.5 The silt fence will be measured by the linear foot (linear meter) to the nearest 1/2 ft (meter). Measurement will be along the top of the fence for each continuous run in place with no allowance for splices or overlaps.

4.6 Storm Water Pollution Prevention Plan will be measured as a unit. A unit will include preparation, submittals, modifications, and resubmittals.

4.6.1 Monitoring SWPPP and Erosion and Sediment Controls will be measured to the nearest 1/2 of an hour, for the actual number of authorized hours spent monitoring the construction site(s) and off-site areas specified in 3.2 and on-site monitoring report preparation. Monitoring Erosion and Sediment Control will not be measured when there is no item for this work.

4.6.1.1 Travel time and other time not spent at the construction site(s) or off-site areas specified in 3.2.2.2 and time not authorized will not be measured.

4.7 Erosion stone will be measured per ton (metric ton) in accordance with 109.01.

Basis of Payment

5.1 The accepted quantities of erosion control work will be paid for at the contract unit price per square yard (square meter) or per acre (hectare) for mulch and per square yard (square meter) for matting, all complete in place.

5.2 Slope seed ordered for permanent erosion control and ryegrass ordered for temporary erosion control will be paid for as provided under 644.

5.3 Hay bales for erosion control will be paid for at the contract price per bale complete in place. No extra payment will be made for removal of bales ordered removed.

5.4 Tackifiers approved for use in 3.3.2 will be subsidiary.

5.5 The accepted quantity of silt fence and replacements as ordered will be paid for at the contract unit price per linear foot (linear meter) installed.

5.5.1 Removing sediment deposits will be paid for under 699.

5.6 The accepted Storm Water Pollution Prevention Plan will be paid for at the contract lump sum price. Initial payment will be up to 75 percent of the amount bid upon approval of the Plan for the entire project. Subsequent payments will be made periodically based on the anticipated construction period.

5.6.1 Modifications and resubmittals of the plan will be subsidiary.

5.6.2 The accepted quantities of Monitoring SWPPP and Erosion and Sediment Controls will be paid for at the contract unit price per hour.

5.6.2.1 Travel time and other time not spent at the construction site(s) or off-site areas and support services (i.e. travel expenses, clerical staff, copying, miscellaneous expenses, overhead) will be subsidiary to Item 645.71.

5.6.3 Erosion and Sediment Control and Stormwater Management items necessary to implement and maintain the Erosion and Sediment Control and Stormwater Management Plan for the construction site(s) will be paid for under the appropriate Items of 645 or as provided under Section 699.5.

5.7 The accepted quantity of erosion stone will be paid for at the contract unit price per ton (ton) delivered to the project and includes any required excavation and stone removal, as ordered.

5.8 The Contractor shall maintain areas with permanent control, with no extra compensation, until the completion of the contract.

5.8.1 Repair and maintenance of damaged or failed slopes, until project acceptance as stated in section 104.13 shall be at the expense of the Contractor.

5.8.2 The Department reserves the right to employ outside assistance or to use its own forces to provide the necessary corrective measures and deduct the cost from money due the Contractor and/or withhold progress payments.

5.9 Erosion control measures including dust control required for stockpiles of materials subject to wind or water erosion shall be at the expense of the Contractor.

Pay items and units:

645.111	Mulch	Square Yard (Square Meter)
645.11	Mulch	Acre (Hectare)
645.12	Temporary Mulch	Acre (Hectare)
645.15___	Bark Mulch___in (mm) Deep	Square Yard (Square Meter)
645.2	Matting for Erosion Control	Square Yard (Square Meter)
645.21	Slope Stabilization (2:1 or Flatter)	Square Yard (Square Meter)
645.22	Slope Stabilization (Steeper than 2:1)	Square Yard (Square Meter)
645.23	Channel Stabilization (Low Velocity)	Square Yard (Square Meter)
645.24	Channel Stabilization (High Velocity)	Square Yard (Square Meter)
645.25	Permanent Stabilization	Square Yard (Square Meter)
645.3	Erosion stone	Ton (Metric Ton)
645.51	Hay Bales for Temporary Erosion Control	Each
645.52	Ryegrass for Temporary Erosion Control	Pound (Kilogram)
645.531	Silt Fence	Linear Foot (Linear Meter)
645.532	Silt Fence with Support Fence	Linear Foot (Linear Meter)
645.7	Storm Water Pollution Prevention Plan	Unit
645.71	Monitoring SWPPP and Erosion and Sediment Controls	Hour

SECTION 646

SECTION 646 -- TURF ESTABLISHMENT

Description

1.1 This work shall consist of preparing the soil and furnishing and applying seed of the type or types specified, fertilizer, limestone, and mulch if required, on all areas designated for turf establishment as shown on the plans or ordered.

1.2 This work shall also consist of furnishing necessary humus or bam as specified in the item description.

Materials

2.1 Limestone shall conform to 642.2.

2.2 Fertilizer shall be that for initial fertilization and shall conform to 643.2.

2.3 Seed shall conform to 644.2 using the type of mixture ordered.

2.4 Mulch shall conform to 645.2.1.

2.5 Mulch tackifiers shall conform to 645.2.6 and be environmentally non-toxic.

2.6 Humus shall conform to 647.2.

2.7 Loam shall conform to 641.2.

Construction Requirements

3.1 Construction requirements shall conform to 641.3, 643.3, 644.3, 645.3 and 647.3.

3.2 Application rate of limestone shall generally be 130 pounds per 1,000 square feet, approximately 3 tons per acre (63.5 kilograms per 100 square meters), unless otherwise ordered.

3.3 Mulch tackifiers shall be used as a tie-down or adhesive for mulch, it shall be used at the rate specified by the manufacturer, and applied uniformly over and through the mulch.

Method of Measurement

4.1 Turf establishment of the type specified will be measured by the acre (hectare) or the square yard (square meter) to the nearest 0.01 of an acre (hectare) or nearest square yard (square meter) from measurements taken on the ground surface covered.

4.2 Turf establishment (F) of the type specified will not be measured, but shall be the square yard (square meter) final pay quantity in accordance with 109.11 for the area within the limits shown on the plans.

Basis of Payment

5.1 The accepted quantities of turf establishment of the type specified will be paid for at the contract unit price per acre (hectare) or square yard (square meter) complete in place.

5.2 Turf establishment (F) of the type specified are final pay quantity items and will be paid for at the contract unit price per square yard (square meter) in accordance with 109.11.

5.3 The material cost of crownvetch seed ordered by the Engineer added to slope seed type specified in the plans will be paid for in accordance with 109.04.

Pay items and units:

646.3	Turf Establishment with Mulch and Tackifiers	Acre (Hectare)
646.31	Turf Establishment with Mulch and Tackifiers	Square Yard (Square Meter)
646.311	Turf Establishment with Mulch and Tackifiers (F)	Acre (Hectare)
646.312	Turf Establishment with Mulch and Tackifiers (F)	Square Yard (Square Meter)
646.4	Turf Establishment with Mulch, Tackifiers and Humus	Acre (Hectare)
646.41	Turf Establishment with Mulch, Tackifiers and Humus	Square Yard (Square Meter)
646.411	Turf Establishment with Mulch, Tackifiers and Humus (F)	Acre (Hectare)
646.412	Turf Establishment with Mulch, Tackifiers and Humus (F)	Square Yard (Square Meter)
646.5	Turf Establishment with Mulch, Tackifiers and Loam	Acre (Hectare)
646.51	Turf Establishment with Mulch, Tackifiers and Loam (F)	Square Yard ((Square Meter)
646.511	Turf Establishment with Mulch, Tackifiers and Loam (F)	Acre (Hectare)
646.512	Turf Establishment with Mulch, Tackifiers and Loam (F)	Square Yard ((Square Meter)

SECTION 647 -- HUMUS**Description**

1.1 This work shall consist of salvaging humus material encountered in the work or furnishing humus material from other sources, and placing the material at the locations shown on the plans or ordered.

SECTION 647

Materials

2.1 Humus shall be the surface layer of natural workable soil containing organic matter, or material of a generally humus nature capable of sustaining the growth of vegetation, with no admixtures of refuse or material toxic to plant growth. It shall be relatively free from stones, lumps, stumps or similar objects larger than 2 inch (50 mm) in greatest diameter, sterile soil, roots, and brush. Ordinary sods of herbaceous growth such as grass and non-noxious weeds will be permitted. Muck, dry enough to be properly measured and spread may be used if it meets the above requirements, but the Engineer reserves the right to prohibit the use of muck which he considers may be or may become a fire hazard. If muck is accepted, extra limestone, sand, or humus material, shall be added as ordered by the Engineer.

Construction Requirements

3.1 The material shall be spread over the properly prepared areas to give a covering which will be approximately 3-1/2 inch (90 mm) thick, with generally not less than 3 inch (75 mm) or more than 4 inch (100 mm), measured normal to the slope.

Method of Measurement

4.1 Humus material will be measured by the cubic yard (cubic meter). Slope measurements will be taken of the lengths and widths of the material in place and the volume will be computed by using the nominal depth of 3-1/2 inch (90 mm).

Basis of Payment

5.1 The accepted quantity of humus will be paid for at the contract unit price per cubic yard (cubic meter) complete in place.

5.1.1 Excavation required to undercut slopes in order to accommodate the material will be subsidiary.

Pay item and unit:

647.1	Humus	Cubic Yard (Cubic Meter)
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SECTION 648 -- SOD

Description

1.1 This work shall consist of furnishing and placing live grass sod, including sod gutters, as shown on the plans or ordered. This work shall also include any excavation necessary to place the sod.

Materials

2.1 Sod shall consist of an approved, dense, vigorous, well-rooted growth of commercial turf of perennial grasses indigenous to the area where it is to be used.

2.1.1 The sod shall be free from noxious weeds, annual grasses, large stones or roots, or other materials harmful to growth, or which would interfere with mowing or future maintenance.

2.1.2 The soil shall be of such character that the sod will not break or crumble.

2.2 Pegs for holding shall be of sound wood approximately 3/4 inch (19 mm) square or round, and 8 to 10 inch (200 to 250 mm) long.

Construction Requirements

3.1 Sodding seasons. Unless otherwise permitted, sodding shall be done between April 1 and June 1, or between August 15 and October 15, but not when the ground or sod is frozen.

3.2 Cutting sod. The sod shall be cut with an approved sod cutter into strips of uniform width having minimum dimensions of 12 by 18 inch (300 by 460 mm). The sod shall be severed below the root line, shall have a uniform thickness and shall contain the majority of the feeding roots of grasses.

3.3 Site Preparation.

3.3.1 Areas to be sodded shall be brought to grade with 4 inch (100 mm) of loam as shown or ordered, making allowance for the thickness of the sod.

3.3.2 As necessary, the soil shall be harrowed, tilled, or otherwise loosened to a depth of at least 2 inch (50 mm) to allow for mixing of the soil with the fertilizer and limestone.

3.3.3 The area shall be cleaned of large stones, roots, or other debris which might interfere with laying of the sod.

3.4 Laying Sod.

3.4.1 Sod shall be in a moist condition when laid and shall be placed on a reasonably moist bed. The sod shall be carefully placed and tightly fitted edge to edge. Any broken, damaged, or irregular shaped sod will be rejected.

3.4.2 On slopes, the sod shall be laid at right angles to the slope, beginning at the bottom.

3.4.3 Transverse joints shall be staggered, and any unavoidable gaps shall be filled with sod plugs or loam.

3.4.4 All sod shall be tamped with an approved tamper or roller to insure tight joints and a smooth uniform surface.

3.4.5 The inlet edges of sod in waterways and other edges exposed to water scour shall be turned down and buried to a depth of 3 inch (75 mm) with tamped earth.

3.4.6 On slopes steeper than 4:1, every other line of sod shall be fastened with wooden pegs spaced 3 ft (1.0 m) apart and driven flush with the surface of the sod.

3.4.7 Single lines of sod for anchoring loam on slopes greater than 4:1 shall be secured as 3.4.6.

3.4.8 After laying, all sod shall be thoroughly watered immediately after rolling, and in the absence of rain repeat every day until the roots have grown into the soil. (Normally rooting requires two to three weeks.)

SECTION 648

Method of Measurement

4.1 Sod will be measured along the slope, except that the width of gutters will be as shown on the plans or ordered. Dead sod will not be measured. Sod will be computed to the square yard (square meter).

Basis of Payment

5.1 The accepted quantity of sod will be paid for at the contract unit price per square yard (square meter) complete in place.

5.2 Excavation required to complete this work will be considered as incidental to the items, but fertilizer, limestone, and loam ordered will be paid for under the respective items.

Pay item and unit:

648	Sod	Square Yard (Square Meter)
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SECTION 650 -- PLANTING - GENERAL

Description

1.1 This specification includes general requirements that are applicable to all types of planting, including trees, shrubs, vines and ground cover plants, irrespective of type. Deviations from these general requirements will be indicated in the specific requirements for each type.

1.2 This work also includes furnishing and installing landscaping materials, including all layout, fertilizing, soil conditioning, staking, guying, watering, excavating, weeding, herbicides, fungicides, pesticides, refertilizing as necessary, replanting as needed, and stake and guy removal after the establishment period, as shown on the plans or as ordered.

Materials

2.1 Plants.

2.1.1 General.

2.1.1.1 Plant material shall meet the current specifications of the "American Standard for Nursery Stock" as published by the American Association of Nurserymen unless otherwise specified.

2.1.1.2 All plants shall be first class and shall be representative of their normal species or varieties. All plants must have a good, healthy, well formed upper growth and a large, fibrous, compact root system.

2.1.1.3 All plants shall be nursery grown stock that has been transplanted unless indicated as "seedlings", or root pruned at least once every 4 years. Plant hardiness shall be determined acceptable by the Engineer as specified relative to the zone of origin. A sworn affidavit as to region of growth shall be furnished when ordered.

2.1.1.4 Unless otherwise specified, so-called exposed or “bare-root” material will be accepted. Container grown plants may be furnished in lieu of balled and burlapped plants, provided they meet the current specifications in the American Standard for Nursery Stock.

2.1.1.5 Any non-bid substitution of plant material shall be acceptable only if the bid item(s) is unavailable. Requests for plant substitutions and proof of unavailability shall be furnished to the Engineer in writing one month prior to the beginning of the planting season.

2.1.2 Names and Marking.

2.1.2.1 All scientific and common plant names of the items specified shall conform with the current edition of “Hortus Third” compiled by the staff of the L. H. Bailey Hortorium, Cornell University. All plants delivered shall be true to name.

2.1.2.2 Each bundle, or each plant, when not tied in bundles, shall be legibly and properly labeled. Care shall be taken throughout the operation to keep each plant species or variety segregated and labeled. The Engineer may reject at any time any plant material of questionable nomenclature.

2.1.3 Inspection.

2.1.3.1 All plants shall be free from plant diseases and insect pests, and shall comply with all applicable State and Federal laws with respect to inspection for plant diseases and infestations.

2.1.3.2 Plant material may be inspected in the nursery or collecting fields before it is dug. The Contractor shall provide a list of suppliers in sufficient time so the Engineer may inspect nurseries on a timely bases. Approval to move nursery material to the project site shall not be considered as Acceptance. The Contractor shall notify the Engineer not less than 48 hours in advance of delivery of plants.

2.1.3.3 All planting stock shall conform to the laws of New Hampshire and shall be inspected before removal from the nursery, by authorized Federal, State or other authorities as may be required in the area where the nursery is located. The invoice or order for each shipment of plants shall contain the project name and number and the quantity and variety of plant material delivered. An inspection certificate shall certify that the plants are free of disease and insect pests of all kinds and shall accompany each shipment. Disease certificates and delivery slips shall be given to the Engineer upon arrival of the plant material at the point of delivery.

2.1.3.4 For purchase of material from nurseries within New Hampshire, information regarding inspection for plant disease and pest infestations is available from the New Hampshire Department of Agriculture. Inspection of plants from outside New Hampshire is controlled by the United States Department of Agriculture and information is available from the United States Department of Agriculture, Animal & Plant Health Inspection Service.

2.1.4 Digging, Handling, and Packing.

2.1.4.1 General. Plants shall be dug with care and skill. Special precautions shall be taken to avoid any unnecessary injury to, or removal of fibrous roots from the plants. Each species or variety shall be handled and packed in the approved manner for that particular plant. All precautions shall be taken to insure the arrival of the plants at the project site in good condition for successful growth.

2.1.4.2 Balled and burlapped plants. The ball shall be firm and, unless a manufactured ball is allowed, shall be composed of the original and undisturbed soil in which the plant has been grown. The plant shall be handled in such a manner that the soil in the ball will not drop away from the roots and will

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not cause stripping of the small, fine-feeding roots. The ball shall be wrapped with burlap or other approved material and tightly laced to hold the desired shape. Plastic ball wrap material shall not be allowed. No balled plants will be accepted if the ball is cracked or broken. A substitute for burlap may be approved provided it can be demonstrated that the material is tight enough to retain the soil ball securely. During planting operations material which will not readily disintegrate in the ground shall be removed or extensively cut to allow the roots to grow through freely.

2.1.4.3 Bare -root plants. The roots of bare-rooted stock shall be carefully packed in sphagnum moss, moist straw, or other suitable material that will insure the arrival of plants in an acceptable condition.

2.1.5 Shipment.

2.1.5.1 Arrangements shall be made as far as practicable to have plants delivered as the planting pits or beds are ready for them.

2.1.5.2 Plants which have heated or sweated at any time, or have been broken, fractured, scraped, or bruised, will be rejected.

2.1.5.3 All local, state, or federal laws relative to the shipping of plants shall be strictly complied with.

2.1.6 Measurement.

2.1.6.1 Measurement will be made in accordance with the practice prescribed in the current edition of the "American Standard for Nursery Stock" published by the American Association of Nurserymen.

2.2 Blank.

2.3 Blank.

2.4 Layout marking material shall be clean 1 inch x 1 inch x 4 ft (25 x 25 mm x 1.2 m) high hardwood lumber stakes, wire type flagging, 1 inch (25 mm) minimum width plastic flagging or other approved material.

2.5 Plant support materials shall conform to the following unless otherwise specified.

2.5.1 Vertical stakes shall be hardwood lumber stakes or posts 2 inch x 2 inch (50 x 50 mm) minimum square or 1-1/2 inch (38 mm) diameter minimum round of the length required as shown on the plans. Hub stakes shall be 2 inch x 2 inch x 30 inch (50 x 50 x 750 mm) minimum square hardwood lumber.

2.5.2 Guy material for vertically staked trees shall be double strand 3/32 inch (2.7 mm) minimum diameter galvanized wire with hose sleeves, interlocking plastic chain or other common industry approved tree guying material.

2.5.3 Guy material for hub staked trees shall be 3/16 inch (4.7 mm) minimum diameter galvanized wire with hose sleeves.

2.6 Rodenticides, herbicides, and pesticides shall be those approved for use by the New Hampshire Pesticide Control Board.

2.7 Water used in the planting or care of vegetation shall be free from any substance injurious to plant life.

2.8 Antidesiccants shall be of an approved emulsion which will provide a film over plant surfaces, permeable enough to permit the exchange of gases but inhibit the passage of water vapor.

2.9 Fertilizer.

2.9.1 Fertilizer shall be a standard commercial grade fertilizer conforming to all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists. The analysis shall represent respective percentages of nitrogen, phosphoric acid, and potash.

2.9.1.1 All fertilizer shall be identified by labels and shall show the following:

- (a) Guaranteed analysis.
- (b) Name and address of the guarantor of the fertilizer.
- (c) Type or brand.
- (d) Net weight.

2.9.1.2 Dry fertilizer for other than acid-loving plants shall have an analysis of 10-6-4 (preferred), 10-3-6, or 10-5-5, or with written permission, a substitute may be furnished. In any case, a minimum of 35 percent of the nitrogen shall be water-insoluble (35 percent WIN).

2.9.1.3 Water-soluble fertilizer shall be completely water soluble. Fertilizer for other than acid-loving plants shall contain the following minimum percentages of available elements by weight: nitrogen, 16 percent, phosphoric acid, 19 percent, potash, 16 percent. The total available nutrients shall be at least 55 percent by weight.

2.9.1.4 Fertilizer for acid-loving plants shall be formulated for acid-loving plants such as rhododendrons, azaleas, and blueberries. Dry fertilizer for such plants shall have a minimum analysis of 7-7-7 or as approved. Water-soluble fertilizer for such plants shall have an analysis in the range of 21-7-7 or as approved.

2.10 Soil Conditioners.

2.10.1 Peat moss shall be air-dried, granulated, sphagnum peat moss, nearly free from woody substances, consisting of at least 75 percent of partially decomposed stems and leaves of sphagnum, and essentially brown in color. The texture may vary from porous fibrous to spongy fibrous and shall be free of sticks, stones, and mineral matter. Peat moss shall not show an acid reaction of less than 3.5 pH.

2.10.2 Peat humus shall be natural peat or peat humus from fresh water saturated areas, consisting of sedge, sphagnum, or reed peat, and shall be of such physical condition that it will pass through a 1/2 inch (12.5 mm) mesh screen. The humus shall be free from sticks, stones, roots, and other objectionable materials. Samples taken at the source of supply shall meet the following requirements:

Acidity:	not less than 4.0 pH.
Minimum water absorbing ability:	200 percent by weight on oven-dry basis.
Minimum organic content:	60 percent when dried at 221 °F (105 °C).

2.10.2.1 Freshly excavated peat, if saturated with water, shall be stored for a sufficient length of time to condition it for workability.

2.10.3 Humus material other than peat humus shall conform to 647.2.

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2.11 Mulches.

2.11.1 Wood chips shall be obtained primarily from disease-free green hardwood, shall be 1/4 inch (6 mm) in nominal thickness, and 50 percent shall have an area of not less than 1 square inch (650 square millimeters) nor more than 6 square inches (4000 square millimeters). Not more than 2 percent shall consist of leaves, twigs, or shavings, and it shall be free of materials injurious to plant growth. Wood chip mulch must be approved prior to use. Where wood chips are specified, bark may only be used when permitted.

2.11.2 Bark mulch shall be bark chippings graded to be approximately 3/8 to 2 inch (10 to 50 mm) in width. The chippings shall not have been stored so long and under such conditions that the material has decomposed sufficiently so that it has lost its fibrous texture. Bark mulch must be approved as to grading and condition prior to its use. Where bark mulch is specified, wood chips may only be used when permitted.

2.11.3 Other mulch material may be used upon approval.

2.12 Loam Backfill.

2.12.1 Loam backfill when existing soils are not acceptable, shall be relatively free of roots or rhizomes of witchgrass. No sticks, sods, clods or other material which would tend to form large air pockets in the soil shall be included. The use of muck will not be permitted around any plantings.

2.12.2 Loam backfill shall have minimum and maximum pH values of 6.0 and 7.6, respectively. Organic matter, as determined by loss by ignition, shall be from 6 percent to 20 percent. Natural topsoil with a pH over 4.5 and over 4 percent organic may be amended to meet these specifications.

2.12.3 A loam source will be sampled and tested by the Engineer so that the results are obtained at least three days prior to planting and prior to the addition of soil amendments. Planting shall not begin prior to loam approval.

2.12.4 After the test results are known, amendments shall be made, when necessary to meet the minimum pH and organic standards.

2.12.5 To each cubic yard (cubic meter) of accepted loam, the following shall be added and thoroughly mixed to produce loam backfill: 2 to 3 cubic feet (0.07 to 0.11 cubic meters) of well rotted cow manure (dehydrated cow manure at a rate specified by the Engineer); 4 cubic feet (0.15 cubic meters) of sphagnum peat moss; 15 lb (8.9 kg) of 10-6-4 fertilizer minimum 50 percent water insoluble (WIN); and 20 lb (11.9 kg) of ground agricultural limestone.

2.12.5.1 When permitted, compost or individual components of the loam backfill may be added directly to the approved plant pits.

2.12.5.2 Batch size for mixing shall be determined by the Engineer, typically 15 cubic yards (11.5 cubic meters).

Construction Requirements

3.1 Planting Seasons.

3.1.1 Unless otherwise directed, seasons for planting shall be within the following dates:

Deciduous/Evergreen Material:	Spring - April 1 to June 30
	Fall - August 15 to November 15

3.1.2 Preparations for planting may begin earlier than the specified season, and if approved, planting work may continue beyond the specified time limits. Permission to extend planting dates shall be requested in writing to the Engineer at least 10 working days before the end of the planting season. The request shall include a legitimate reason for the extension. Any anticipated shortages of plant material shall be brought to the attention of the Engineer upon discovery.

However, the Engineer may require that all plants planted out of season, except deciduous material planted prior to April 1 and after November 15, shall be balled, burlapped, and dead or damaged branches removed.

3.1.3 No planting shall be done when the site or weather is unsatisfactory for planting, unless permitted.

3.2 Delivery and Inspection.

3.2.1 A preliminary check will be made of all plants at the time of delivery for condition of the plants and general conformity to the specifications. A more thorough inspection of individual plants will be made just prior to planting. No plants shall be planted which have not received this inspection. In order to facilitate this inspection, the Contractor shall inform the Engineer, at least 24 hours in advance, as to what plants are to be planted and in what location. Any plants without receiving this inspection will be rejected and if rejected must be removed and replaced with inspected stock.

3.2.2 Due to the difficulty of identifying dormant plants and to the effect of handling on the health and vigor of plants, only conditional approval will be given to plants in preliminary and intermediate inspections. Inspection will continue throughout the life of the Contract up to the time of Acceptance. Plants discovered at any time which are not true to name, do not conform to the specifications, show evidence of improper handling or lack of proper care, or which appear to be in a seriously unhealthy condition for any other reason must be removed from the project site at once and replaced by acceptable plants as soon as the planting season allows.

3.2.2.1 Subject to approval of the Engineer, plants which show minor infestations of insects or disease appearing after planting may be treated in lieu of being replaced.

3.2.3 At least 3 working days before digging any collected or plantation-grown material, the Contractor shall notify the Engineer of the time and place of digging so that inspection of the work and of the material may be made by the Engineer.

3.3 Protection and Temporary Storage.

3.3.1 The Contractor shall keep all plant material moist and protected from drying out. Protection shall be provided during the time the plants are in transit, in temporary storage, or on the project site awaiting planting.

SECTION 650

3.3.2 Unless otherwise approved by the Engineer, plants delivered, but not scheduled for immediate planting, shall be protected as follows:

(a) Bare-root plants shall be heeled-in in moist soil in a satisfactory manner. All plants heeled-in shall be properly maintained by the Contractor until planted.

(b) Balled and burlapped plants shall have the earth balls covered with wood chips or other suitable material and shall be kept in a moist condition.

3.3.3 The Contractor shall exercise the utmost care in loading, unloading, or handling of plants to prevent injuries to the branches or to the roots of the plants. The solidity of balled and burlapped plants shall be carefully preserved.

3.3.4 While plants with exposed roots are being transported to and from heeled-in beds, or are being distributed in planting beds, or are awaiting planting after distribution, the Contractor shall protect the roots from drying out by means of wet canvas, burlap, or straw, and watering, if necessary. The means employed shall be satisfactory and shall depend on weather conditions and the length of time the roots must remain out of the ground.

3.4 Layout.

3.4.1 The Engineer may adjust plant material locations to meet field conditions. Project plant material locations and bed outlines shall be delineated (flagged, marked, staked, etc.) on site by the Contractor, per the plan, for review and approval by the Engineer. Plant locations may be adjusted by the Engineer to meet local site conditions. All layout marking material required shall be furnished by the Contractor.

3.4.2 Ten working days prior to the start of planting work on the project, the Contractor shall provide a planting schedule to be used in establishing priorities in laying out plant locations. The Contractor shall give at least 2 working days notice of any deviations from this schedule. The Engineer will not be responsible for any delays or inconvenience resulting from the Contractor's failure to follow the above procedure.

3.4.3 An artificial appearance in the layout scheme is generally not desired. Except where uniform spacing may be required, as in the case of snow-control planting and the like, some variation in spacing is essential and care must be taken to avoid straight lines and uniform spacing unless directed otherwise.

3.5 Excavation.

3.5.1 Excavation for plant pits shall not begin before the approved loam backfill is available on the project.

3.5.2 Holes for plant material shall be excavated at the indicated locations and shall be of sufficient size to permit not less than 6 inch (150 mm) of loam backfill beneath and 12 inch (300 mm) around the outer periphery of the root system or ball. Plant pit requirements are shown on the planting detail sheet.

3.5.2.1 Trenching may be ordered for special sites such as long narrow medians. Trenches shall provide a minimum 12 inch (300 mm) of loam backfill beneath and around the outer edge of the plant ball.

3.5.3 Blank

3.5.4 Surplus excavated material or material unsuitable for backfill or saucer construction shall be removed from the site as soon as practicable or disposed of as ordered.

3.5.5 When rock or boulders over 1/3 cubic yard (1/4 cubic meter) in size are encountered in digging plant pits, the Contractor shall notify the Engineer, who will change the location of the plants. No excavation of rock or boulders over 1/3 cubic yard (1/4 cubic meter) in volume will be required.

3.5.6 If topsoil on the planting site is acceptable as loam, the topsoil encountered in the excavation may be used for loam backfill when it is kept separate from the subsoil. Soil amendments may be required. See 2.12.4.

3.5.7 In certain areas of poor drainage or heavy soil, the Engineer may require that the soil excavated from the plant pit be spread on the ground adjacent to the pit and neatly distributed so as to raise the grade of the area to provide better surface drainage. Where shown on the plans or directed, such pits may also require ditches. When ditches are required, they shall be included as a part of the cost of the plant. Beds constructed by trench method must be raised sufficiently to permit drainage to flow alongside and not into the bed.

3.5.8 Where permitted, bare-root evergreens such as seedlings or transplants may be planted in the existing soil. Plant holes must be deep enough to allow room for the full depth of the root without doubling, folding, or pruning, and wide enough to allow room for its normal spread. Plants must be set straight and at the same depth at which they were previously growing. Soil must be firmly compacted around the roots, leaving no air pockets. In heavy grass the Engineer may require that the sod be removed or folded back to a distance of 4 to 6 in (100 to 150 mm) from the main stem of each plant, or require herbicide treatment in advance of planting.

3.6 Setting Plants.

3.6.1 General.

3.6.1.1 Plants shall be set to depths appropriate to the various types of material, local drainage, and the special requirements of each. In general, plants shall be placed on backfill that has been firmly settled so that the root crown is even with or slightly higher than the ground level. Roses and budded or grafted plants shall be set at least 3 inch (75 mm) below their previous earth line or as directed.

3.6.1.2 All trees and shrubs shall be planted plumb.

3.6.1.3 As shown on the planting detail sheets, the ground around the plants shall be graded and rims shall be constructed at the edge of the plant pit for each plant, forming a saucer capable of holding sufficient water to give the root system a good soaking. Saucer rims shall be tamped so as to be durable enough to allow several years of watering if necessary. To prevent the growth of weeds and noxious grasses, the rims shall be constructed from soil removed from the plant pits. Imported loam for backfill shall not be used in the construction of the plant saucer rims and every effort shall be made to prevent spillage of loam in the planting area.

3.6.1.3.1 Saucers shall be inspected and approved by the Engineer prior to placement of mulch.

3.6.2 Planting and Backfilling Bare -Root Plants.

3.6.2.1 Prepared backfill soil shall be placed in the plant pit to the required minimum depth and very slightly tamped. Plants shall then be placed in the center of the pit and roots properly spread out in a natural position. All broken or damaged roots shall be cleanly cut back to healthy root growth.

3.6.2.2 Backfill soil shall then be carefully worked around and over the roots, with thorough watering. Care shall be taken to avoid the bruising or breaking of roots.

SECTION 650

3.6.3 Planting and Backfilling Balled and Burlapped Plants.

3.6.3.1 Plants of this type shall be handled and placed in holes in such a manner that the soil of the ball will not be loosened. After the hole has been partly backfilled and the soil watered under and around the ball, the burlap and ties at the top of the root ball shall be cut away and removed to avoid girdling, and the remaining burlap slit on the sides and adjusted to prevent the formation of air pockets and the basket cut and loosened. Backfilling and watering shall then be completed in a manner to avoid loosening the soil of the root ball.

3.6.4 Planting and Backfilling Potted Plants.

3.6.4.1 All containers shall be carefully removed prior to planting. Pot-bound material shall be subject to rejection if proper root pruning cannot be accomplished in a manner acceptable to the Engineer.

3.7 Fertilizing.

3.7.1 Initial fertilization shall consist of the use of dry fertilizer, water-soluble fertilizer, or a combination of both as permitted.

3.7.1.1 Dry fertilizer, when not included in the loam backfill, including fertilizer for acid-loving plants as appropriate, shall be uniformly mixed with the loam used as backfill about the plants at the following rates:

- (a) Trees: 1-1/2 lb/in (0.03 kg/mm) of caliper.
- (b) Shrubs: 1/4 lb/ft (0.4 kg/m) of height.
- (c) Vines: 1/2 lb (0.2 kg) per vine.

3.7.1.2 Water-soluble fertilizer, when ordered by the Engineer, including fertilizer for acid-loving plants as appropriate, shall be dissolved in water at the rate recommended by the manufacturer. The thoroughly mixed solution shall be applied at the time of initial planting after the water used for backfill soaking has leached away. Care shall be taken to prevent washing plant saucers away either during the original watering or while applying water-soluble fertilizer.

3.7.1.2.1 The fertilizer solution shall be applied at the following rates:

- (a) Seedling plants, except coniferous: 1 pint (0.5 L) per plant.
- (b) Plants up to 2 ft (0.6 m) in height shall receive 4 quarts (3.8 L).
- (c) Plants over 2 ft (0.6 m) and up to 6 ft (1.8 m) shall receive 6 quarts (5.7 L).
- (d) Plants over 6 ft (1.8 m) and up to 12 ft (3.6 m) shall receive 12 quarts (11.4 L).
- (e) Plants over 12 ft (3.7 m) shall receive 16 quarts (15.1 L).

3.7.2 Refertilization.

3.7.2.1 Unless otherwise ordered, up to two refertilizations shall be done using a water-soluble fertilizer applied in conjunction with watering or by itself. No refertilization will be allowed between August 1 and plant dormancy and between frozen ground and April 1.

3.7.2.2 All plants except seedlings and root plantings shall be fertilized at least once between April 1 and August 1 with water-soluble fertilizer mixed and applied in accordance with 3.7.1.2 or as directed when applied with a watering. Dry fertilizer for acid-loving plants may be used for such plants provided it is dissolved in sufficient water to make a workable solution and the solution is applied around the outside drip line of the branches at the rate of 1/4 lb/ft (0.4 kg/m) of height of shrub.

3.7.2.3 When the contract period extends spring to spring, all plants except seedlings and root cuttings shall receive an additional application of fertilizer in the spring prior to Acceptance.

3.8 Watering.

3.8.1 Watering equipment shall be on the project prior to planting and shall be available at any time during the life of the project. This equipment shall provide enough water to thoroughly soak the plant material root systems for the entire project within 48 hours. Watering equipment shall be equipped with a regulating device on the end of the hose to provide the operator with the ability to control the flow and pressure of water. Plants shall be watered immediately following planting, preferably when two-thirds of the backfill has been placed so all air pockets are removed and the plant properly set. Then a later watering to thoroughly soak the root system shall be performed within 24 hours of planting. Thereafter, watering shall be done every week throughout the growing season unless otherwise directed.

3.9 Guying and Staking.

3.9.1 When require or ordered by the Engineer all trees shall be staked and guyed in a taut manner in accordance with the details shown on the plans as soon as the plant is in place. Guy material shall be loosely secured to the tree to provide for growth of the trunk and allow approximately 1 inch (25 mm) sway in the tree. Hub stakes shall not protrude more than 8 inch (200 mm) above the ground.

3.9.2 All stakes and guys shall be removed after the establishment period unless otherwise directed

3.10 Antidesiccant Spray.

3.10.1 Antidesiccant spray shall be used when directed.

3.11 Pruning.

3.11.1 Pruning of dead or damaged branches shall be done preferably before or immediately after planting in such a manner as to preserve the natural character of each plant. All pruning shall be done by experienced personnel with properly conditioned equipment and in keeping with accepted horticultural practice.

3.12 Mulching.

3.12.1 Within 48 hours of planting a plant, unless a longer period is allowed, mulch material shall be furnished and placed over all pit or saucer areas of individual trees, shrubs, and vines, and over the entire area of shrub beds to the depth indicated on the plans. Mulch material shall either be bark mulch or wood chips. Saucers shall be inspected prior to placement of mulch or chips.

3.13 Restoration and Cleanup.

3.13.1 Where existing grass areas have been damaged or scarred during planting operations, the disturbed areas shall be restored to their original conditions as directed at no additional cost to the Department. Mowing may be required when directed by the Engineer to insure complete slope restoration. All debris, spoil piles, containers and the like shall be cleaned up and the project left in an acceptable condition after each planting season. All slopes shall be left in a smooth condition with ruts and excavated soils removed and areas regraded as required.

SECTION 650

3.14 Establishment Period.

3.14.1 The acceptability of the plant material furnished and planted as specified will be determined at the end of the establishment period. The period of establishment shall begin as soon as all plants are planted and shall extend for 1 year or until the date of Acceptance, whichever date is later. During this period, the Contractor shall continuously monitor the condition and general health of the plantings and initiate all horticultural practices necessary to maintain plants in a healthy condition including watering, fertilization, weeding, pesticide application, rodent control, pruning, repairing saucers, adding mulch, adjusting guys and stakes, and replacement of unacceptable plants, together with such other work as may be ordered. Weeding shall be a minimum of 1 ft (300 mm) beyond the limit of the saucers. At the end of the establishment period, all guys, stakes, and hubs shall be removed, unless otherwise directed.

3.14.2 An inspection will be made by the Contractor and the Engineer immediately prior to or early in the planting season following the original planting season to determine the condition of the plant material. Dead plants, diseased plants, plants lacking sufficient vigor, or plants showing evidence of sizable die-back shall be replaced. Unacceptable plant material must be removed promptly from the project.

3.14.3 The Engineer may require that replacement plants that are not dormant or that are planted late in the planting season shall be sprayed as directed with an approved antidesiccant.

3.14.4 Except as provided in 2.1.1.5, all replacement plantings shall be of the same kind and size as originally specified. The use of more loam and more initial fertilizer may be waived by the Engineer; otherwise, replacement plantings shall be handled, planted, and maintained in the same manner specified for the original plantings.

3.15 Herbicides, Insecticides, and Fungicides.

3.15.1 The Engineer may order, or the Contractor may request, the use of an approved herbicide at planting locations when it is determined that the chemical control of weeds is necessary.

3.15.2 The Engineer may order, or the Contractor may request, the use of a suitable insecticide or fungicide when it is determined that infestations of insects or plant disease require the use of such material.

3.15.3 All herbicides, insecticides, and fungicides shall be applied as prescribed by their manufacturer and in accordance with New Hampshire laws. The Contractor shall either possess from the New Hampshire Pesticide Control Board the proper registrations and permits for the application of such materials or have the applications made by an approved, qualified firm holding such registrations and permits. Copies of all permits in connection with such materials shall be furnished to the Engineer. All pesticide application within the right-of-way or project limits will require a special permit from the New Hampshire Department of Agriculture, Division of Pesticide Control.

3.16 Protection Against Rodents.

3.16.1 Rodent protection is a required part of plant care during the life of the contract. An approved rodenticide shall be used on all plants that are susceptible to rodent damage. Approval for the proposed rodenticide and for the method of application must be obtained from the New Hampshire Department of Agriculture, Division of Pesticide Control and copies of the approval shall be furnished to the Engineer. A mixture of wood alcohol and rosin may be used in the absence of an approved rodenticide.

Method of Measurement

4.1 Plant material will be measured by the number of units of plants in healthy condition, of the specified sizes and species, furnished and planted.

4.2 Landscaping will be measured as a unit. A unit will include furnishing and installing landscaping materials, including all layout, fertilizing, soil conditioning, staking, guying, watering, excavating, weeding, herbicides, fungicides, pesticides, refertilizing as necessary, replanting as needed, and stake and guy removal after the establishment period, as shown on the plans or as ordered.

Basis of Payment

5.1 All work performed will be paid for as provided under the appropriate Sections 651 through 659.

5.2 When substitutions are approved, payment will be by supplementary agreement.

5.2.1 Any non-bid substitution of collected stock as described in 2.1.1.5 will be subject to a price reduction of 25%.

5.3 Excessive damage due to heavy insect infestations, if all reasonable precautions are taken by the Contractor, will be reason for consideration of extra payment for approved replacements.

5.4 The accepted quantity of landscaping unit will be paid for at the contract lump sum price complete in place.

5.4.1 The Contractor shall submit a "Bill of Materials" for approval in accordance with 105.02 at least three weeks prior to starting the landscaping item. The "Bill of Materials" shall include a unit price breakdown of planting materials. Once approved, this list will be used as a basis to adjust the landscaping item if substitution of plant material is required.

5.4.1.1 Anticipated shortages in any particular plant material shall be brought to the attention of the Engineer and Roadside Development Section. Upon such discovery, the Contractor shall promptly request for plant material substitution in writing. The request shall include at least ten (10) Certified Nursery sources that were contacted for confirmation. The Contractor shall also submit the price of the proposed substitute material.

5.4.1.2 Upon approval of the substitute plant material, the Engineer will adjust the unit price, either increase or decrease, by multiplying the number of substituted plants by the difference between the base plant price and the substituted plant price. The result will then be divided by the unit price to come up with the new adjusted unit.

Pay Items and Units:

650.2

Landscaping

Unit

SECTION 651

SECTION 651 -- EVERGREEN TREES

Description

1.1 This work shall consist of furnishing and planting evergreen trees of the specified size and type at the locations shown or as ordered.

Materials

2.1 Materials shall conform to the requirements of 650.2.

Construction Requirements

3.1 Construction requirements shall be as prescribed in 650.3.

Method of Measurement

4.1 Evergreen trees will be measured as prescribed in 650.4.

Basis of Payment

5.1 The accepted quantities of evergreen trees will be paid for at the contract unit price per each for trees of the specified sizes and species complete in place.

Pay item and unit:

651. __	(Specific Evergreen Tree)	Each
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SECTIONS 652 AND 653 -- DECIDUOUS TREES

Description

1.1 This work shall consist of furnishing and planting deciduous trees of the specified size and type at the locations shown or as ordered.

Materials

2.1 Materials shall conform to the requirements of 650.2.

Construction Requirements

3.1 Construction requirements shall be as prescribed in 650.3.

Method of Measurement

4.1 Deciduous trees will be measured as prescribed in 650.4.

Basis of Payment

5.1 The accepted quantities of deciduous trees will be paid for at the contract unit price per each for trees of the specified sizes and species complete in place.

Pay items and units:

652.__	(a)	(Specific Deciduous Tree)	Each
653.__	(a)	(Specific Deciduous Tree)	Each

(a) These pay item numbers have been assigned to this section in order to accommodate the many varieties of deciduous trees on the landscape list used by the Department.

SECTION 654 -- EVERGREEN SHRUBS

(Needle and Broadleaf)

Description

1.1 This work shall consist of furnishing and planting evergreen shrubs (needle and broadleaf) of the specified size and type at the locations shown or as ordered.

Materials

2.1 Materials shall conform to the requirements of 650.2.

Construction Requirements

3.1 Construction requirements shall be as prescribed in 650.3 and when directed, shrubs shall be guyed in the same manner as trees, as prescribed in 650.3.9.1.

Method of Measurement

4.1 Evergreen shrubs will be measured as prescribed in 650.4.

Basis of Payment

5.1 The accepted quantities of evergreen shrubs will be paid for at the contract unit price per each for shrubs of the specified sizes and species complete in place.

Pay item and unit:

654.__	(Specific Evergreen Shrub)	Each
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SECTIONS 655 & 656

SECTIONS 655 AND 656 -- DECIDUOUS SHRUBS

Description

1.1 This work shall consist of furnishing and planting deciduous shrubs of the specified size and type at the locations shown or as ordered.

Materials

2.1 Materials shall conform to the requirements of 650.2 as amended below.

2.2 Sweetfern sods shall be 12 by 12 inch (300 by 300 mm) sods, 2-1/2 to 3 inches (65 to 75 mm) thick. All sods shall have 3 or more woody stems of native sweetfern plants with original natural soil surrounding the roots. Sods shall be free from noxious weeds.

2.3 When the plans call for smooth and staghorn sumac, collected, the plants furnished shall be a mixture of approximately 40 percent of the smooth variety and 60 percent of the staghorn variety unless otherwise permitted.

2.3.1 Sumac plants shall be at least 2 years old. The minimum allowable caliper of the stem shall be 1/4 inch (6 mm), measured at least 6 inch (150 mm) above the ground. Plants higher than 5 ft (1.5 m) shall not be collected. The main roots (rhizomes) shall be at least 6 inch (150 mm) long each side of the stem. The top may be pruned prior to or after planting, provided the remaining plant is not less than 18 inch (460 mm) high.

Construction Requirements

3.1 Construction requirements shall be as prescribed in Section 650.3 as amended below.

3.2 Deciduous shrubs shall be pruned in the same manner as specified for trees in accordance with 650.3.11, except that sumac shrubs shall not be pruned in the fall.

3.3 Sweetfern.

3.3.1 Collection of sweetfern may be made during the dormant season, but not later than May 1 except by permission. Planting of the item may start as early in the spring as the ground may be worked and shall be completed not later than June 1 except by permission. Protection from dehydration during collecting, storing, and planting shall be as described under 650.3.3.

3.3.2 The roots of sweetfern plants, unless otherwise ordered, shall be planted horizontally in freshly prepared (moist) pits at a depth of 4 to 6 inch (100 to 150 mm), at the spacing shown on the plans. The stem section of the crowns shall be cut back to approximately 2 to 3 inch (50 to 75 mm) above the ground or so that it will appear approximately 1 inch (25 mm) above the mulch or as directed. Before the ground around the planting has had time to dry out, an application of hay mulch shall be applied at the rate of 3 to 4 tons per acre (7.0 to 9.0 metric tons per hectare) or as ordered.

3.3.3 No fertilizer will be required with planting of sweetfern.

SECTIONS 655 & 656

3.3.4 When sweetfern sods are required, sods shall not be stored in such a manner as to compress the thickness of the sod below the minimum 2-1/2 inch (65 mm) specified. Generally, storage will not be permitted for longer than 5 days. Sods which have been stored beyond this time limit, and sods which have become dried out or broken prior to placement in final position may be rejected.

3.3.4.1 Sods shall be firmly incorporated into the soil at the designated spacing. Hay mulch shall be required as specified in 33.2. The Contractor shall take all necessary precautions in maintaining a healthy sod from the date of actual planting until Acceptance.

3.4 Sumac.

3.4.1 Sumac plants may be collected until May 25.

3.4.2 The plant pit shall be dug large enough to easily accommodate the root system with 1/3 ft³ (0.01 m³) extra on the bottom. At least 1/3 ft³ (0.01 m³), approximately 12 quarts (10 L) of loam well mixed with 1/2 lb (0.2 kg) of dehydrated cow manure shall be added before the plants are placed in the pit.

3.5 Autumn Elaeagnus (Autumn Olive).

3.5.1 Autumn elaeagnus, 15 to 24 inch (380 to 610 mm) shall be planted and fertilized in the manner specified in 3.4.2.

Method of Measurement

4.1 Deciduous shrubs will be measured as prescribed in Section 650.4.

4.2 Sweetfern sods will be measured per each 12 by 12 inch (300 by 300 mm) sod.

Basis of Payment

5.1 The accepted quantities of deciduous shrubs will be paid for at the contract unit price per each for shrubs of the specified sizes and species complete in place.

5.1.1 Hay mulch used in connection with sweetfern will be subsidiary.

Pay items and units:

655. __	(a)	(Specific Deciduous Shrub)	Each
656. __	(a)	(Specific Deciduous Shrub)	Each

(a) These pay item numbers have been assigned to this section in order to accommodate the many varieties of deciduous shrubs on the landscape list used by the Department.

SECTIONS 657

SECTION 657 -- VINES AND GROUND COVERS

Description

1.1 This work shall consist of furnishing and planting vines and ground covers of the specified size and type at the locations shown or as ordered.

Material

2.1 Materials shall conform to 650.2.

Construction Requirements

3.1 Construction requirements shall be as prescribed in 650.3.

Method of Measurement

4.1 Vines and ground covers will be measured as prescribed in 650.4.

Basis of Payment

5.1 The accepted quantities of vines and ground cover will be paid for at the contract unit price per each for vines or ground cover of the specified sizes and species complete in place.

Pay item and unit:

657.__	(Specific Vine or Ground Cover)	Each
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SECTION 658 -- TRANSPLANTING PLANT MATERIAL

Description

1.1 This work shall consist of digging up plant material consisting of trees, shrubs, and vines, and transplanting such at the locations shown or ordered. If temporary storage is necessary, care shall be taken to heel-in or plant the material where it can receive proper care until the permanent site is ready.

Materials

2.1 Materials shall conform to the requirements of 650.2, except that the plant material shall consist of the existing plants designated.

2.1.1 Where plant materials are designated to be moved and insufficient root systems or other faults are found in the existing plants, the Engineer may direct that new plants from nursery stock of similar or approved species be substituted.

Construction Requirements

3.1 Construction requirements shall conform to the applicable construction requirements of 650 through 657 for the type of plant material being transplanted.

Method of Measurement

4.1 Transplanting plant material will be measured as prescribed in 650.4.

Basis of Payment

5.1 The accepted quantities of plant material transplanted will be paid for at the contract unit price per each complete in place.

5.2 When new plant material has been ordered, payment will be made for furnishing and planting such plants under the appropriate item.

Pay item and unit:

658.__	Transplantation (Specific Plant Material)	Each
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SECTION 692 -- MOBILIZATION

Description

1.1 This item shall consist of preparatory work and operations, including, but not limited to, those necessary to the movement of personnel, equipment, supplies, and incidentals to the site of the work; and for all other work and operations which must be performed or for costs which must be incurred prior to beginning work on the various items.

Method of Measurement

4.1 This item will be measured as a unit.

Basis of Payment

5.1 Partial payments for this item will be made approximately as follows:

(a) When 5 percent of the original contract amount is earned, the accumulated total to be paid will be 25 percent of the amount bid, or 2-1/2 percent of the original Contract amount, whichever is the lesser.

(b) When 10 percent of the original contract amount is earned, the accumulated total to be paid will be 50 percent of the amount bid, or 5 percent of the original Contract amount, whichever is the lesser.

(c) When 25 percent of the original contract amount is earned, the accumulated total to be paid will be 60 percent of the amount bid, or 6 percent of the original Contract amount, whichever is the lesser.

(d) When 50 percent of the original contract amount is earned, the accumulated total to be paid will be 100 percent of the amount bid, or 10 percent of the original Contract amount, whichever is the lesser.

SECTION 692

5.2 Upon completion of all work, payment of any amount bid for this item in excess of 10 percent of the original Contract amount will be paid.

5.3 Upon written request by the Contractor made within 30 days of the Award of Contract, an amount equal to 25 percent of the amount bid for this item or 1 percent of the Contract amount, whichever is lesser, will be paid. Further partial payments will be made according to the schedule in 5.1.

5.4 The total sum of all payments will not exceed the original Contract amount bid for this item, regardless of the fact that the Contractor may have, for any reason, shut down his work on the project or moved equipment away from the project and then back again.

5.5 When the item for mobilization is not included in the proposal form, the costs as described in the item will not be paid for directly, but shall be considered incidental to other items in the proposal.

Pay item and unit:

692	Mobilization	Unit
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SECTION 693 -- TRAINING PROGRAMS**Description**

1.1 This specification amplifies and interprets the requirements for the training program established by the Federal Aid Program Manual, Vol. 6, Ch. 4, Sec. 1, Subsec. 2, Attach. 2 entitled "Training Special Provisions" and hereinafter referred to as the Training Program.

1.2 The primary objective of the Training Program is to provide equal employment opportunity to minorities and disadvantaged persons by providing training and upgrading with the goal of reaching journeyworker status and retaining them in the highway construction industry. However, the training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

1.3 The Contractor may determine how many, if any, of the trainees are to be trained by subcontractors. However, the Contractor shall have the primary responsibility for meeting the training requirements. The number of trainees to be trained under this Contract is shown in the proposal.

Requirements**3.1 Recruiting.**

3.1.1 The Contractor shall insure that the training and promotion of all employees will be considered on a non-discriminatory basis, and will advise employees and applicants for employment of available training programs and entrance requirements for these programs.

3.1.2 The Contractor shall actively pursue enrollment of minorities and women into the program by conducting a systematic recruiting effort through public and private sources likely to yield minorities and women trainees. To the extent that such persons are available in a reasonable recruiting area, the Contractor shall be able to demonstrate the steps that were taken in this pursuit.

3.1.3 The Contractor shall take positive steps to prevent any employee from being employed as a trainee in any classification in which the employee has successfully completed a training course leading to journeyworker status or in which the employee has been employed as a journeyworker. The Contractor may meet this requirement by including appropriate questions in the employee application or by other means. The Contractor's records shall document the findings.

3.2 Orientation and Counseling.

3.2.1 The Contractor shall provide pre-job orientation to new employees entering the training program. This will include discussing the advantages and disadvantages of construction work, namely the seasonality of work in New Hampshire, the mobility necessary, safety hazards and requirements, weather conditions, etc. The Contractor shall also familiarize the trainee with the construction industry informing the trainee of the trainee's responsibility to the Contractor and the Contractor's responsibility to the trainee. Also, the Contractor shall stress the importance of safety on the job.

3.2.2 The Contractor shall be responsive to any potential problems that may develop in the program. The Contractor shall work closely with all persons involved in the training program providing guidance and counseling to trainees and taking positive steps to resolve any misunderstandings ensuring a successful training experience.

SECTION 693

3.3 Training.

3.3.1 As specified in the Training Program, the Contractor is required to submit to the Engineer for approval the number of trainees to be trained in each selected classification along with the training program and the intended starting time for each trainee. This shall be done prior to commencing construction allowing a reasonable time frame for the Engineer to study the Contractor's request.

3.3.2 The Contractor may use programs as provided by the Engineer or may use any training program approved by the Department of Labor or by the FHWA as of the date of proposed use. The Contractor shall notify the Engineer if he plans to use such programs.

3.3.3 The Contractor's on-site Equal Employment Opportunity (EEO) Officer shall work with Federal and State agencies and unions, as required, and with on-site superintendents and supervisors to structure an acceptable detailed training program.

3.3.4 The number of trainees shall be distributed among the work classifications on the basis of the company's needs and the availability of journeyworkers in the various classifications within a reasonable area of recruitment. At a minimum, the training program for contractors and subcontractors, will adhere to the following guidelines:

3.3.4.1 Training will be conducted and/or supervised by an experienced supervisor.

3.3.4.2 Supervisors will be in contact with each trainee on a daily basis in order to ensure that proper training is being provided.

3.3.4.3 A copy of the training program will be given to each trainee, along with an explanation of all requirements necessary to complete the program and what further opportunities for formal training may be expected upon successful completion.

3.3.4.4 The detailed training program for the trainee will include:

- (a) safety indoctrination in the use of tools, equipment, personal protection devices, first-aid, traffic control and other applicable skills;
- (b) a period of observation of operation prior to work assignment and performance;
- (c) instruction and then participation in actual operations, care and maintenance of tools and/or equipment, where applicable;
- (d) a review period at the end of each week with the Contractor's project managers in order to encourage the trainee to ask questions and have meaningful discussions.

3.3.5 Trainees will be paid at least 60 percent of the appropriate minimum journeyworker's rate specified in the contract for the first half of the training period, 75 percent for the third quarter of the training period, and 90 percent for the last quarter of the training period. The reduced rate, though, shall not be less than \$7.00 per hour with the exception that when the trainee is also enrolled in an approved apprentice or other training program, the rate of compensation approved by the Department of Labor shall apply without reduction.

3.4 Promotion and Retention.

3.4.1 The Contractor shall periodically review the training and promotion potential of minority and female employees and shall encourage eligible employees to apply for such training and promotion, to provide every opportunity for their upgrading within the Company.

3.4.2 The Contractor shall be responsible to document its effort to promote and retain minorities and females within the construction industry.

3.5 Reporting.

3.5.1 The Contractor shall maintain weekly records of training provided to each trainee. In addition, the Contractor shall complete a quarterly report for each trainee receiving training under this specification, furnishing the following information on forms supplied:

- (a) Contractor's name and address.
- (b) Trainee's name, address, age, social security number, ethnic group designation, and whether trainee is a new hire or is being upgraded.
- (c) A summary of previous training received on other contracts under approved training programs.
- (d) The job classification for which training is provided, the date training started, and the type training (apprenticeship or other) to be provided.
- (e) The hours of training provided to the trainee during the quarter.
- (f) The total hours of training remaining to complete the approved training program.
- (g) Reasons for the termination if training was terminated prior to completion of the approved program.

3.5.2 The Contractor shall submit reports for any training under this specification which is provided by any of his subcontractors.

3.5.3 The Contractor shall submit the quarterly reports by the 15th day of the month following the end of the quarter. The original of the report shall be furnished to the trainee and two copies furnished to the Engineer.

Method of Measurement

4.1 The Contractor will have fulfilled his training responsibilities if he has provided acceptable training to the number of trainees specified in the contract.

4.2 On this project, permission may be given by the Engineer to pay for more than the number of trainees specified in the contract, provided the Contractor proposes acceptable training programs to meet his needs and the needs of the industry.

Basis of Payment

5.1 Progress payments may be made to the Contractor based on 80 cents for each hour of the training provided.

5.2 No payment shall be made to the Contractor if either the failure to provide the required training, or the failure to hire the trainee as a journeyworker, is caused by the Contractor and there is evidence of a lack of good faith on the part of the Contractor in meeting these requirements.

5.3 The Bidder's attention is called to the dollar amount inserted in the proposal under this item, which dollar amount represents \$600 times the number of workers specified to be trained under the program. This figure must not be altered by the Bidder in his proposal, and must be included to obtain the grand total of the bid.

5.4 Payment of the amount set in the proposal will not be on a lump sum basis. Payment will be made to the Contractor at the rate of \$0.80 per hour (whether or not the time worked is overtime), for the hours worked by a trainee.

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Pay item and unit:

693	On-the-Job Training of Unskilled Workers	Dollar
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SECTION 698 -- FIELD FACILITIES

Description

1.1 Under this section, the Department will pay for the use of Contractor owned and Contractor maintained field offices Type A, Type B, Type C, Type D and physical testing laboratories during the construction of the project. This work will include installing, leveling, maintaining, and removing facilities and providing the required equipment and services. The location of the facilities shall be subject to the approval of the Engineer.

Materials

2.1 General. Housing for field offices and laboratories shall be buildings or trailers which meet the following minimum requirements:

2.1.1 Field Office Type A.

Dimensions:	Minimum of 725 ft ² (67 m ²) of floor area. Minimum of 7 ft (2.1 m) in height.
Interior:	Minimum of three partitioned areas. One area shall be approximately 120-150 ft ² (11-14 m ²) for the installation of all computer components with interior door and lock. Another area shall be approximately 250 ft ² (23 m ²) for use as a conference room. Each major area shall have telephone plug-in jacks. The computer area shall have an additional telephone jack for the computer.
Lavatory:	Built-in lavatory and toilet facilities including shower with hot and cold water.
Closets:	Included in each partitioned area; approximately 22 inches deep by 3 feet (560 mm deep by 1.0 m) wide with locks.
Windows:	Minimum of two per partitioned area with locks, screens and storm windows providing cross ventilation.
Doors:	Minimum of two with locks and screens.
Electrical:	Adequate overhead lighting at each work area and two power outlets per room, including one exterior outlet and one exterior light near entrance.
Air Conditioner(s):	Central air conditioning or a minimum of two individual units (one in the computer area) sized to maintain a maximum temperature of 78° F (26° C).

Heat: Thermostatically controlled to maintain a minimum temperature of 68° F (20 ° C).

Weatherproofing: Roof, sides, and floor shall be maintained weatherproof at all times.

2.1.2 Field Office Type B.

Dimensions: Minimum of 610 ft² (57 m²) of floor area. Minimum of 7 ft (2.1 m) in height.

Interior: Minimum of three partitioned areas. One area shall be approximately 120-150 ft² (11-14 m²) for the installation of all computer components with interior door and lock. Another area shall be approximately 250 ft² (23 m²) for use as a conference room. Each major area shall have telephone plug-in jacks. The computer area shall have an additional telephone jack for the computer.

Lavatory: Built-in lavatory and toilet facilities with hot and cold water.

Closets: Included in each partitioned area; approximately 22 inches deep by 3 feet (560 mm deep by 1.0 m) wide with locks.

Windows: Minimum of two per partitioned area with locks, screens and storm windows providing cross ventilation.

Doors: Minimum of two with locks and screens.

Electrical: Adequate overhead lighting at each work area and two power outlets per room, including one exterior outlet and one exterior light near entrance.

Air Conditioner(s): Central air conditioning or a minimum of two individual units (one in the computer area) sized to maintain a maximum temperature of 78° F (26° C).

Heat: Thermostatically controlled to maintain a minimum temperature of 68° F (20 ° C).

Weatherproofing: Roof, sides, and floor shall be maintained weatherproof at all times.

2.1.3 Field Office Type C.

Dimensions: Minimum of 320 ft² (30 m²) of floor area. Minimum of 7 ft (2.1 m) in height.

Interior: Minimum of one partitioned area approximately 125 ft² (12 m²) with interior door and lock.

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Lavatory:	Built in lavatory and toilet facilities with hot and cold water where available.
Closet:	Built in, approximately 22 in deep by 3 feet (560 mm deep by 1.0 m) wide.
Windows:	Minimum of four with locks, screens and storm windows providing cross ventilation.
Door:	Minimum of two with locks and screens.
Electrical:	Adequate overhead lighting at each work area and two power outlets per room, including one exterior outlet and one exterior light near entrance.
Air Conditioner(s):	Central air conditioning or a minimum of two units (one in computer area) sized to maintain a maximum temperature of 78° F (26°C).
Heat:	Thermostatically controlled to maintain a minimum temperature of 68° F (20 °C).
Weatherproofing:	Roof, sides, and floor shall be maintained weatherproof at all times.

2.1.4 Field Office Type D and Field Laboratory.

Dimensions:	Minimum of 200 ft ² (18 m ²) of floor area. Minimum of 7 ft (2.1 m) in height.
Windows:	Minimum of two with locks and screens providing cross ventilation.
Lavatory:	Toilet
Closet:	Built in, approximately 22 inches deep by 3 feet (560 mm deep by 1.0 m) wide.
Door:	Minimum of one with lock and screen.
Electrical:	Adequate overhead lighting at each work area and two power outlets per room, including one exterior outlet.
Air Conditioner:	Central air conditioning or individual unit(s) sized to maintain a maximum temperature of 78° F (26° C).
Heat:	Thermostatically controlled to maintain a minimum temperature of 68° F (20 °C).
Weatherproofing:	Roof, sides, and floor shall be maintained weatherproof at all

times.

2.2 Field Office Equipment.

2.2.1 Equipment Required for all Field Offices.

Water Cooler:	1, 5 gallon (19 L) capacity, bottled water supplied and maintained.
MUTCD:	The current edition of the <i>Manual on Uniform Traffic Control Devices for Streets and Highways</i> and any supplements or amendments thereto, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
Current AASHTO Specifications and Testing Manuals:	Part I and II of the current American Association of State Highway and Transportation Officials Standard Specifications for Transportation Materials and Methods of Sampling and Testing including yearly interim supplements, available from the American Association of State Highway and Transportation Officials, 444 North Capital Street, N.W., Washington, DC 20001.
Measuring Wheel:	Steel disk, 15 in (380 mm) minimum diameter with capacity to record up to 10,000 feet to the tenth of a foot (3 km to the nearest 30 mm), built-in stand, and storage case.
4' direct reading level.	
10' metal straight edge	light-weight metal straightedge with a rectangular cross-section of 2 by 4 in (50 by 100 mm)
Marking Paint:	Adequate supply, lead-free, non-clogging; color: fluorescent orange or as ordered.
Pencil Sharpener:	1, standard size.
Thermometer:	1, indoor/outdoor type.
Floor Broom/Dust Pan:	1 each.
First Aid Kit:	Shall contain a minimum of: 20-adhesive bandages, 3/4 in (20 mm) wide. 1-first aid tape, 1/2 by 180 in (13 mm by 4.5 m). 1-flexible gauze bandage, 2 by 126 in (50 mm by 3.2 m). 1-flexible gauze bandage, 4 by 126 in (100 mm by 3.2m). 1-triangular bandage 10-antiseptic swabs 3-sterile pads, 3 by 3 in (75 by 75 mm) 3-ammonia inhalants antiseptic cream aspirin eyewash kit

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	poison ivy cream scissors tweezers 1, current first aid book
Computer Equipment	As required by the supplemental specification included in the proposal.
Digital Paging Device:	A numeric (digital) display electronic pager.
Cellular Phone	Cellular hand set shall have a 1/3-watt nominal power output, shall have a carrying case, DC adapter (cigarette lighter operation), battery charger, hand free adapter, and owners manual. The minimum service area shall be Maine, New Hampshire, Vermont, and Massachusetts with a minimum 90% coverage area. A minimum service plan of 300 minutes per month shall be provided.
“Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays”, Guideline No. 03732 and Concrete Surface Profile Chips (required when projects contain concrete bridge deck):	Technical guidelines and rubberized 3-1/2 in X 5-1/2 in (87.5 X 137.5 mm) replicas of typical surfaces to provide a visual standard for purposes of specification, execution and verification. Available from the International Concrete Repair Institute, 1323 Shepard Drive, Suite D, Sterling, Virginia 20164-4428, (703) 450-0116.

2.2.2 Additional Equipment for Field Office Type A Type B , Type C and Type D.

Water:	Water service to supply lavatory, if available.
Fire Extinguisher:	Type A, B & C: 2, multi-purpose (A, B, C), dry powder, minimum 5 lb (2.2 kg) size. Type D: 1, multi-purpose (A, B, C), dry powder, minimum 5 lb (2.2 kg) size.
Office Desks:	Type A & B: four furnished with drawers. Type C: four furnished with drawers. Type D: one furnished with drawers.
Desk Chairs:	Type A & B: four Type C & D: two
Folding Table:	Type A & B: Approximately 8 by 4 ft (2.4 by 1.2 m).
Folding Chairs:	Type A: ten Type B: ten Type C: four
Drafting Tables:	Type A, B & C: 2, at least 6 feet by 3 feet - 3 in (1.8 m by 1 m), approximately 3 ft (1.0 m) high, with two drafting stools per

table.

Type D: 1, at least 6 feet by 3 feet-3 inches (1.8 m by 1 m), approximately 3 ft (1.0 m) high, with two drafting stools per table

Calculator/Adding Machine: Type A, B & C: 2, desktop print/display with minimum of ten digits.

Type D: 1 desktop print/display with minimum of ten digits.

Photo Copier: 1, desktop, letter and legal size, minimum of eight copies per minute, reduction and enlarging capability with supplies and maintenance.

File Cabinet: 1 four-drawer, or 2 two-drawer, fire resistant, legal size; inside dimension approximately 10 by 15 by 26 in (250 by 380 by 660 mm) each, with lock(s) and key(s). The file shall bear an Underwriter's Laboratories "C" Label - 350°F (177° C) for one hour, inside surface.

Plan Rack or File: Type A & B: two, for 2 by 3 ft (600 by 900 mm) prints
Type C & D: one, for 2 by 3 ft (600 by 900 mm) prints

Vacuum Cleaner: 1, electric, utility shop-vac (10 gal [38 L] capacity minimum).

Camcorder: 1, new, or used with a recently performed service check verified by an invoice, video camcorder in VHS-C format with date index capability, 12:1 power zoom, 1 lux low light sensitivity, auto focus, auto tracking and hot shoe. Also to be included with this camcorder shall be instruction books, two batteries and a charging/adaptor device, lens protector, tripod, light with battery pack including battery and charging/adaptor device, carrying case for camcorder and light, minimum of five blank cassettes or tapes, one cleaning tape and a VHS-C playback adapter to allow for direct play in a VHS-format VCR.

Facsimile Machine: This machine shall have the capability of sending and receiving 8-1/2 X 11 in on (212.5 X 275 mm) paper on a single separate committed telephone line. The following minimum specifications shall also apply:

Transmission time	16 seconds per page at standard resolution
Transmission speed	10ms/line @ 98 lines/in (4 lines/mm)
Reception speed	20ms/line @ 98 lines/in (4 lines/mm)
Document length	14.5 in (370 mm) maximum, 4 in (100 mm) minimum
Auto document feed	15 pages maximum
Horiz. print resolution	203 pixels/in (8 pixels/mm)
Vertical print resolution	98 lines/in (4 lines/mm), standard

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All connections and supplies necessary to allow successful operation of this machine shall be provided by the Contractor.

2.2.2.1 The field office Type D shall also include the following testing equipment for determining gradation of gravels. This testing equipment shall be maintained in a satisfactory condition.

- (a) Balance: triple beam, at least 2000 grams capacity, sensitive to 0.1 gram, including carrying case.
- (b) Field scale: at least 70 lb (32 kg) capacity, sensitive to 0.01 lb (0.005 kilogram).
- (c) Hot plate or stove: two-burner, electric or bottled gas.
- (d) Sieves: set of U.S. Standard 8 in (200 mm) brass, 2 in (50 mm) high, consisting of one each No. 16 and No. 200 (1.18 mm and 0.075 mm) sieves, with pan and cover.
- (e) Shaker: motor driven, for 8 in (200 mm) sieves.
- (f) Riddles: set of 16 in (400 mm) wood, metal or plastic consisting of one each 3 inch, 2 inch, 1-1/2 inch, 1 inch, 3/4 inch and No. 4 (75 mm, 50 mm, 37.5 mm, 25.0 mm, 19.0 mm, and 4.75 mm).
- (g) Canvas: heavy, 5 by 5 ft (1.5 by 1.5 m), for quartering samples.
- (h) Miscellaneous small tools and containers: shovels (one round pointed and one square pointed), assorted pans such as cake tins, and two pails.
- (i) Proctor mold: 4 in (101.6 mm), capacity 1/30 ft³ (0.000943 m³) (AASHTO T 99).
- (j) Proctor hammer: 5.5 lb (2.5 kg), free fall of 12 in (305 mm) (AASHTO T 99).
- (k) Straight edge: steel (1-1 /2 to 2 in [38 to 50 mm] wide), with a 12 in (305 mm) beveled edge.

2.2.3 When a field office does not contain an operational toilet as part of the interior equipment, an additional facility fabricated from steel, fiberglass, or wood, housing a portable chemical toilet, shall be provided by the Contractor. This building shall be well ventilated, shall conform to State law, and shall have a vented chemical tank and a separate urinal.

2.2.4 Field offices shall be for the exclusive use of Department personnel.

2.2.5 Desk chairs shall be 5 pedestal on wheels and adjustable with back support, drafting stools shall likewise be adjustable and have back support. All office furniture shall be in good, safe working order and condition.

2.3 Field laboratory equipment. The physical testing laboratory shall be provided with the scientific equipment required to perform physical tests for embankment compaction and grading, and for determining the suitability of the base course materials in conformity with standard AASHTO procedure. Following is a list of minimum equipment required to be maintained in a satisfactory condition for the use of the Engineer and the Contractor:

- (a) Proctor mold: 4 in (101.6 mm), capacity 1/30 ft³ (0.000943 m³) (AASHTO T 99).
- (b) Proctor hammer: 5.5 lb (2.5 kg), free fall of 12 in (305 mm) (AASHTO T 99).
- (c) Straight edge: steel (1-1/2 to 2 in [38 to 50 mm] wide), with a 12 in (305 mm) beveled edge.
- (d) Balance: triple beam, at least 2000 grams capacity, sensitive to 0.1 gram, including carrying case.
- (e) Field scale: at least 70 lb (32 kg) capacity, sensitive to 0.01 pounds (0.005 kilograms).
- (f) Hot plate or stove: two-burner, electric or bottled gas.
- (g) Shaker: motor driven, for 8 in (200 mm) sieves.
- (h) Density apparatus: 6 in (150 mm) sand cone, 4 standard G mason jars, and base plate (AASHTO T 191).
- (i) Standard 1/10 ft³ (0.003 m³) container: steel, (6 in [150 mm] diameter).

- (j) Sieves: set of U.S. Standard 8 in (200 mm) brass, 2 in (50 mm) high consisting of one each No. 4, 8, 16, 50, 100, and 2 each No. 40 and 200 (4.75 mm, 2.36 mm, 1.18 mm, 0.300 mm, 0.150 mm, and 2 each 0.425 mm and 0.075 mm) sieves, with pan and cover.
- (k) Riddles: set of 16 in (406 mm) wood or metal, consisting of sizes 3 in, 2 in, 1-1/2 in, 1 in, 3/4 in, 1/2 in and No. 4 (75 mm, 50 mm, 25 mm, 19 mm, 12.5 mm, 9.5 mm and 4.75 mm).
- (l) Sand blasting sand: minimum of 100 lb (45 kg), passing No. 10 (2.00 mm), retained on No. 30 (0.600 mm) standard sieve; maintained on hand at all times.
- (m) Canvas: heavy, 5 by 5 ft (1.5 by 1.5 m), for quartering samples.
- (n) Moisture determination apparatus (Speedy Moisture Tester): calcium carbide type, 20 gram or 26 gram size.
- (o) Sieve shaker: mechanical, for gravel, (mounted outside and independent of the laboratory building) holding 18 by 24 in (460 by 600 mm) tray including 2 in, 1-1/2 in, 1 in, 3/4 in and No. 4 (50 mm, 37.5 mm, 25.0 mm, 19.0 mm, and 4.75 mm) screens.
- (p) Fire extinguisher: 1, multi-purpose (A,B,C) (dry powder) minimum 5 lb (2.2 kg) size.
- (q) Graduate: 100 mL, plastic.
- (r) Miscellaneous small tools and containers: shovels (one round pointed and one square pointed), crowbar, pickaxe, 6 in (150 mm) blade knife, sampling spoon, small trowel, measuring scoop, assorted pans similar to roasting pans and cake tins, and a floor broom.
- (s) Bench oven: electric, 110 volt, minimum volume 7.5 cubic feet (0.2 cubic meters).
- (t) Sample splitter: minimum chute width 1 in (25 mm).

2.3.1 The laboratory shall be furnished with a heavy work table approximately 3 ft (1.0 m) high by 3 ft (1.0 m) wide and extending the length of the building. Suitable shelves and benches shall be provided as directed.

2.3.2 The laboratory shall be equipped with an elevated clean water tank having a minimum capacity of 275 gal (1040 L) which shall be supplied with potable water as directed. The tank shall be piped to a faucet at an approved sink within the laboratory.

2.3.3 To provide a suitable foundation for the mold to rest on when the AASHTO T 99 density test is being performed, a solid block of concrete approximately 18 in (460 mm) deep, having a flat top approximately 1 ft (300 mm) square shall be set practically flush in the ground at an approved location near the field laboratory.

2.3.4 This field laboratory and equipment is in addition to any other requirements specified in Sections 401 and 520.

2.4 Miscellaneous Office Supplies. In addition to the materials listed in 2.1, 2.2 and 2.3, the Engineer may require the Contractor to furnish miscellaneous office supplies such as field books, cross section paper, looseleaf binders, etc., as appropriate.

Construction Requirements

3.1 Facilities.

3.1.1 Field offices and field laboratories shall be on the project, leveled and ready for use prior to the start of any operations. Acceptance of the physical testing laboratory will not be given until the equipment has been inspected and approved by representatives of the Bureau of Materials and Research. Testing equipment shall be calibrated by the Contractor in accordance with 106.03. These facilities shall be removed when the project is completed unless released earlier by the Engineer.

3.1.2 When field offices or field laboratories are to be placed on private property, the costs incidental to such placement shall be born by the Contractor. Prior to Acceptance of the Work, the area

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shall be restored to the acceptance of the property owner and the Engineer. A written release from the property owner will be required.

3.1.3 Field offices and field laboratories shall not be combined, nor shall they be combined with the scale house or other similar structure.

3.2 Maintenance, Service, and Utilities.

3.2.1 The Contractor shall furnish the following for a field office Type A, Type B, Type C, Type D or physical testing laboratory:

- (a) Fuel. Adequate supply for heating and testing operations.
- (b) Electricity. A 3,000 watt, 115-125 volt AC facility for each field office and field laboratory. Independent generators shall be provided where commercial power is not available.
- (c) Telephone. Telephone service, telephone and telephone message recorder shall be provided in the field office. Telephone service shall include a separate line for the telephone with 2 jacks one adjacent to the computer, a separate voice-grade, touch-tone dialing line for the computer modem, and a third voice-grade, touch-tone dialing line for the FAX machine. All necessary hardware and appurtenances for the computer modem shall be provided to the computer room, when a computer is supplied.
- (d) Sanitary. Sanitary facilities shall be serviced and maintained in a sanitary condition.
- (e) Maintenance, including trash pickup and disposal.

3.2.2 The Contractor shall maintain all furnished equipment in good working condition and shall provide replacement equipment due to breakdown, damage, or theft within two (2) working days of notice.

Method of Measurement

4.1 Field offices and Physical testing laboratory of the type specified and used on the project by the Engineer will be measured by the month, from the date each field office or physical testing laboratory is completely furnished and ready for occupancy, as determined by the Engineer, to the date that it is released back to the Contractor. Periods of less than one month will be computed at the rate of 1/30 of the unit price per month for each day of occupancy by the Engineer.

Basis of Payment

5.1 Payment for each accepted Field Office or physical testing laboratory, installed as specified, will be made at the corresponding contract unit price per month. Such payment shall constitute full compensation for furnishing and erecting the field office or physical testing laboratory; for providing the specified utilities and maintaining the field office or physical testing laboratory and its equipment throughout the period of usage by the Engineer; for restoration of the field office or physical testing laboratory site upon completion of the work. The Engineer will determine when the field office or physical testing laboratory is needed on the project, and may terminate its use during suspension(s) of work.

5.1.1 The costs of all project related telephone service, including installation; monthly fees; taxes; any activation fees; internet access as specified; unlimited local calls; and toll calls up to \$300.00 per month shall be paid by the Contractor, subsidiary to the field office. The Department will reimburse the Contractor for any toll calls incurred by State personnel above \$300.00 per month as extra work under Section 104.05.

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5.2 No payment will be made for periods of time in which the Contractor fails to comply with any of the requirements of this specification.

5.3 No payment will be made for time periods for which the Contractor fails to complete the Work on time as specified in 108.07.

5.4 The material cost of miscellaneous office supplies only, will be paid for as provided in 109.04. No payment for labor costs incidental to procuring these supplies will be authorized.

Pay items and units:

698.11	Field Office Type A	Month
698.12	Field Office Type B	Month
698.13	Field Office Type C	Month
698.14	Field Office Type D	Month
698.2	Physical Testing Laboratory	Month

SECTION 699 -- MISCELLANEOUS TEMPORARY EROSION AND SEDIMENT CONTROL

Description

1.1 This work shall consist of miscellaneous temporary measures necessary to control erosion and sedimentation and protect water quality through the life of the Contract. This work includes, but is not necessarily limited to, the use of pipes, berms, dams, sluices, sediment basins, fiber mats, silt booms, filter fabrics, netting, gravel, slope drains and other erosion control devices or methods.

1.2 The miscellaneous temporary erosion and sediment control provisions contained herein shall be coordinated with the permanent erosion control features specified elsewhere in the Contract to the extent practicable to ensure economical, effective and continuous erosion and sediment control throughout the construction and post construction periods.

1.3 The extent of erosion and sediment control will depend upon many factors, among which are the amount and type of soils which may be exposed to erosion.

1.4 The Department recognizes the importance of providing proactive effective erosion and sediment control and that siltation could adversely affect the ecology.

Materials

2.1 Material requirements shall be as specified in 645.2 or as directed.

2.2 Temporary slope drains may be constructed of rigid or flexible pipe, fiber mats, rubble, sluices, plastic sheets or other acceptable material that will protect slopes from erosion.

2.3 Fertilizer and soil conditioners shall meet the requirements of 642 and 643.

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Construction Requirements

3.1 Construction requirements shall be as specified in 645.3 or as directed.

3.2 No work requiring erosion control shall commence until the Erosion and Sediment Control and Stormwater Management Plan has been approved.

Method of Measurement

4.1 Work authorized under this section will be measured as provided in 109.01; however, when such work falls within the specifications for another contract item, the work will be measured according to the method of measurement for that Contract item.

Basis of Payment

5.1 Payment for work authorized under this item will be made on a dollar basis according to 109.04 Method B, C or D.

5.1.1 The cost of construction and maintenance of temporary erosion and sediment control devices not provided for under a separate Contract item will be included for payment under this item.

5.2 Payment for the following work will not be allowed under this item.

5.2.1 The temporary diversion of water during culvert construction and the dewatering, pumping and discharge of water at cofferdams and bridge sites shall be subsidiary to the pertinent Contract item. However, settlement basins, detention ponds or other approved sediment treatment measures required will be included for payment under this item unless otherwise shown on the plans.

5.2.2. Temporary erosion and sediment control measures required due to the Contractor's failure to install permanent controls as a part of the scheduled work, negligence, carelessness or type of operation outside the generally accepted standard construction practices within the State shall be at the Contractor's expense.

5.2.2.1 Temporary erosion and sediment control measures required at off-site areas including, but not limited to, haul roads, equipment and material storage sites, material pits, material processing sites and disposal areas shall be at the Contractor's expense.

5.2.3 Erosion control measures including dust control required for stockpiles of materials subject to wind or water erosion shall be at the Contractor's expense.

5.2.4 Repair and maintenance of damaged or failed slopes, until project acceptance as stated in 104.13 shall be at the Contractor's expense.

5.3 Direct costs plus project engineering costs incurred by the Department to provide corrective temporary erosion and sediment control deemed by the Engineer to be required and not provided by the Contractor will be charged to the Contractor and appropriate deductions made from the Contractor's estimates.

5.4 The dollar amount inserted in the Proposal under this item is the amount the Department has set for miscellaneous temporary erosion and sediment control measures. This amount must not be altered by the Bidder on the Proposal and must be included to obtain the Grand Total of the bid.

5.4.1 Payment of the amount set in the Proposal will not be a lump sum. Only the dollar value as authorized will be paid.

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5.5 When no money for this item is included in the Proposal under this item, it is anticipated that this work will be of minor significance and will be the responsibility of the Contractor.

Pay item and unit:

699	Miscellaneous Temporary Erosion and Sediment Control	Dollar
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